

**Demystifying Readiness-based
Leveling**

$$EBO(s) = \sum_{x=s+1}^{\infty} (x-s)P(x)$$

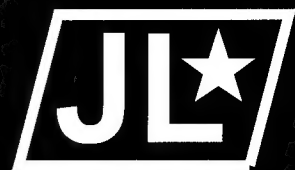
Expeditionary Airpower

Part 1 - A Global Infrastructure to Support EAF

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Demystifying RBL

Major David A. Fulk, PhD, USAF

Whether you call it Readiness-based Leveling (RBL), the D035E system, the Air Force leveling system, or an upgraded version of the D028, RBL is the cornerstone of the supply system for setting recoverable parts levels in the supply system. Developed from the ashes of the old D028 system, RBL was implemented in April 1997 to allocate the worldwide requirement to all bases. In the previous system, Repair Cycle Demand Level (RCDL), levels were computed locally with a relatively simple formula. To know how the level was computed, all one had to do was peruse AFM 23-110. In RBL, levels are computed centrally by Air Force Materiel Command and pushed to the users. The RBL model that calculates the levels has often been viewed as a *black box* where data goes in and levels come out and only a very few people know what goes on inside. Because of this, users often feel that RBL is more of a *shove* system than a push system.

Stock Levels

What Is a Level?

The concept of stock levels for recoverable parts predates RBL, but there seems to be a lack of understanding of the fundamental concept of a level. Since the purpose of RBL is to determine levels, leveling is discussed first.

First and foremost, a level is *not* an asset. However, there should be an asset in some form in the system to cover that level. So a level can be thought of as the number of assets desired.¹ Second, a level is permission for a base to order a part.² If the number of assets on hand plus the number of requisitions in the system is less than the level, additional requisitions are authorized. A level is also a cap on the number of assets a user should have on hand. If by chance the number of assets is larger than a user's level, then the user could (and should) be forced to redistribute the assets to someone else who needs it more. Finally, a level is a method for effectively allocating a scarce resource.

A Level Does Not Equal Assets on Hand

Levels account for requisitions in the system. In fact, levels can generally be thought of as having a *pipeline* portion and a *safety* portion. The old RCDL formula made that easy to understand. The pipeline segment was computed, then a multiple of that segment was added to cover the safety portion. In RBL, these two parts of the level are not computed or reported separately, so it is easy to forget they both exist.

The pipeline portion of the level is designed to cover requisitions in the system. An unserviceable asset is placed in one end of the repair *pipeline*. It flows to the necessary on-base repair shops or depot repair facility and eventually flows back to the base where it comes out the other end of the pipeline as a serviceable asset. The part of the level for the pipeline should be expected to cover assets that are *not* serviceable on hand in stock. The remaining portion of the level, the safety level, is designed to cover some variability in the process. This includes such things as variability in demand, repair time, and order and shipping time. It is not designed and cannot be designed to cover all the variability in the system. Unusual events can occur.

A major misunderstanding concerning levels is that *a level should equate to an on-hand asset*. This is simply not true. On average, only

the safety level should be on hand, and that presupposes all the assumptions made in the pipeline model are true. Serviceable assets on hand will always be less than or equal to the level and many times less than the level.

Is Happiness a Level?

One of the most frequently asked questions is, "Why not let people just order as much as they like? The depot will send out only what they have money to fix." There are numerous problems with this idea. First, this makes requisitions meaningless. Under RBL, users only get a level if they really need one (based on projected demands or an adjusted stock level). A requisition covers past demands and needs to be filled because there is a reasonable chance it will be needed to cover a future demand. Second, the Air Force has only limited resources to buy and repair recoverable assets. These limited resources, along with user needs, are all factored into creating the worldwide requirement. To ignore the requirement (by having levels too high or too low) is an inefficient use of resources. Third, if a user has levels that are too high when compared to others and the actual requirement, they can wind up with assets that are needed more elsewhere. This potential misallocation of assets could cause more back orders (BOs) and nonmission capable aircraft at other bases than it saves at the base with the level that is too high.

Expected Back Orders

Conceptual Example

How does RBL determine levels? It does so by finding a mix of levels for all users (base and depot) that minimizes the user time weighted expected back orders (EBOs). Before discussing how RBL makes this allocation, it will be useful to get a basic understanding of EBOs through a conceptual example.³

In the example in Table 1, on the first day, there are no back orders. On the second day, two back orders occurred, lasting 5 and 7 days respectively. On the third through fifth days, no new BOs were noted, just the existing two BOs. On the sixth day, a third BO was noted and it lasted 3 days. The last new BO was noted on day 9, and it still exists at the end of the 10-day period.

Expected Back Orders: A Definition

The number of BOs in existence on each day is: 0, 2, 3, 2, 1, Taking a daily average gives: $(0+2+2+2+3+2+2+1+1)/10 = 17/10 = 1.7$. This is expected back orders or EBOs. The most common interpretation is EBOs are the average number of BOs in the system at any moment in time. So in the example, on average, there are 1.7

	Day									
	1	2	3	4	5	6	7	8	9	10
1 st Back Order		X	X	X	X	X				
2 nd Back Order		X	X	X	X	X				
3 rd Back Order						X	X	X		
4 th Back Order									X	X

Table 1. EBO Example

(Continued on page 34)

A Global Infrastructure to Support EAF

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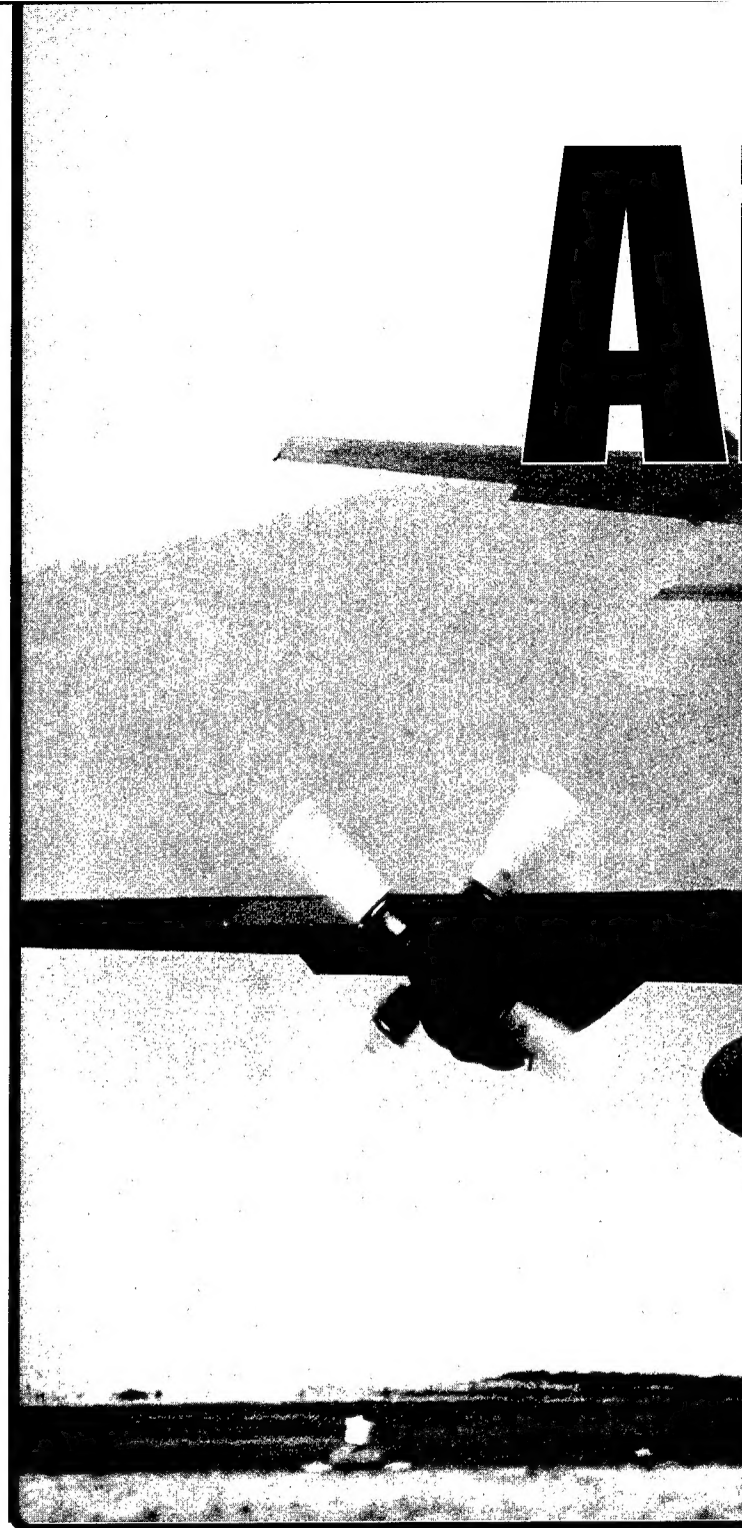
With the end of the Cold War, the United States has entered an entirely new security environment. It is now the only global superpower in a world of many regional powers. The subsequent demands for US military presence or intervention required the US Air Force to stage a large number of deployments—often on short notice and to far-flung locations—with a substantially smaller force than existed in the 1980s. The resulting increased workload and operational turbulence have been blamed for a decrease in retention and recent decreases in overall readiness.¹ In response to these concerns, the Air Force formulated a new concept of force organization, the Expeditionary Aerospace Force (EAF). Under this concept, the Air Force is divided into several Air Expeditionary Forces (AEF), each roughly equivalent in capability, among which deployment responsibilities will be rotated.² Each AEF will have the capability to project highly capable and tailored force packages,³ largely from CONUS, on short notice to any point around the world. Rotating deployment responsibilities among units on an equitable and fairly predictable basis is expected to greatly decrease personnel turbulence.

The shift toward expeditionary operations presents numerous challenges, particularly in combat support. Here, we present analyses that indicate achieving the EAF goals with current support processes requires strategic preparation of a global support infrastructure: the development of a global system of forward locations, judiciously prepositioned materiel, and providing other types of logistics support such as maintenance and transportation. In the sections that follow, we analyze two key aspects of that global infrastructure: forward operating locations (FOLs) and forward support locations (FSLs).

Implementing the EAF: Agile Combat Support

A good deal of Air Force attention has been given to determining AEF composition and scheduling when each AEF will stand ready for its deployment commitment. With respect to deployment responsibilities, much of the Air Force effort concerning support focused on the deployment execution—how to compress timelines for deploying a unit's support functions, given current processes and equipment. Figure 1 illustrates the significant progress made by the Air Force in meeting the EAF's demands to deploy and employ quickly.

Rather than addressing deployment execution activities, we have concentrated on the *strategic* decisions that affect the design of the logistics infrastructure necessary to support rapid deployments. Figure 2 depicts the relationship of strategic decisions to the deployment and redeployment execution decisions illustrated in Figure 1. The large

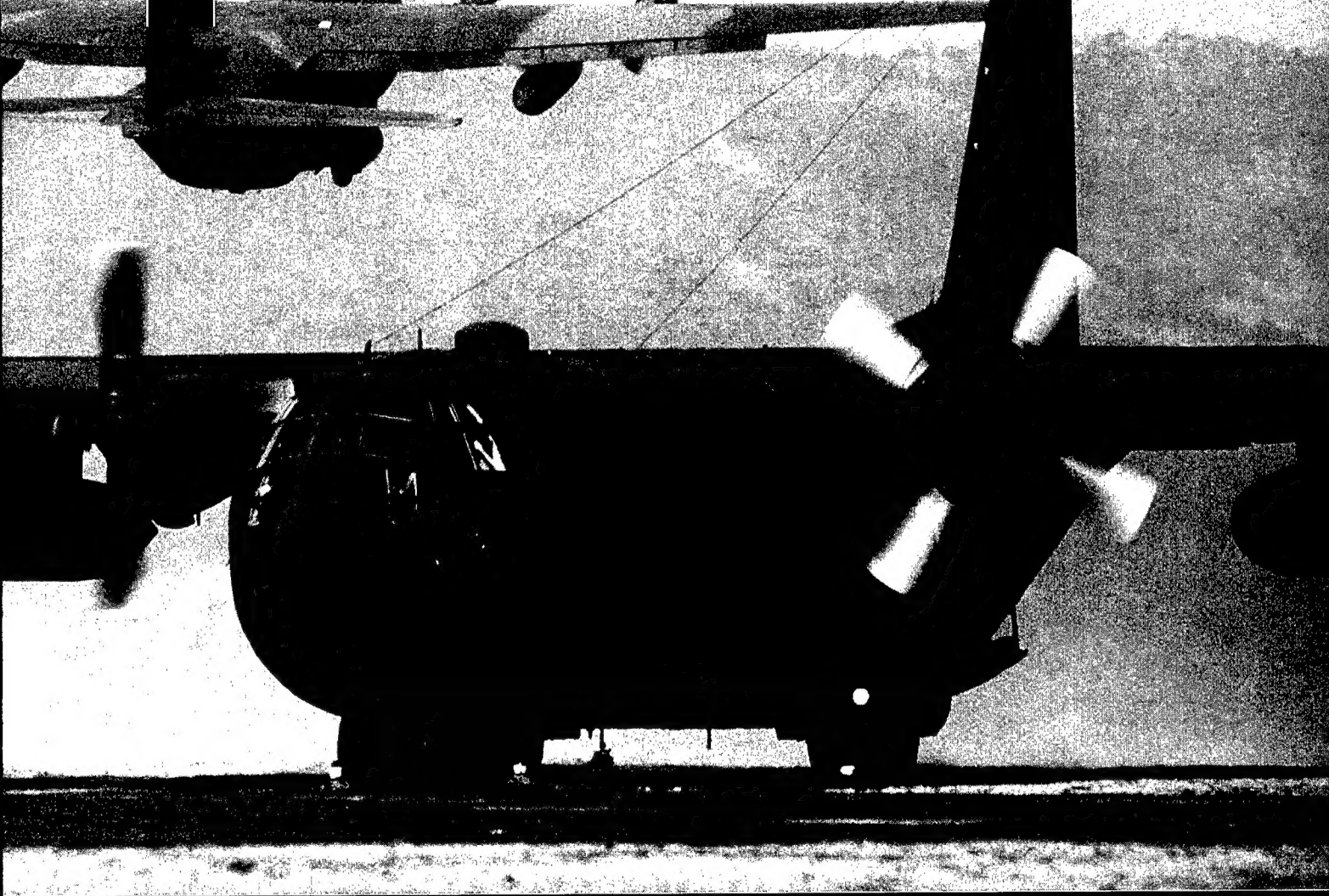


ovals below the readiness-to-reconstitution timeline indicate areas of strategic decision making that need to be addressed. While many of these are topics of ongoing research by RAND, the Air Force Logistics Management Agency, and others, this article focuses on global infrastructure preparation.

GLOBAL Infrastructure Preparation

The original EAF concept envisioned air expeditionary wings (AEWs) deploying to any airfield around the world that had a runway capable of handling the operational and airlift aircraft, regardless of whether the airfield was a fully equipped military base or a *bare base* with minimal facilities. Reliance on prepositioned assets was to be

Expeditionary Power



minimized if not eliminated. Unfortunately, analyses show that at present prepositioned assets cannot be eliminated: the current logistics processes cannot support the timing requirements and most equipment is too heavy to deploy rapidly. While new technologies and policies can improve this situation in the mid to long term, implementing the EAF over the next few years will require some judicious prepositioning at FOLs.

Global infrastructure preparation is, therefore, a central function of planning expeditionary support. Tradeoffs among several competing objectives must be analyzed. These include timeline, cost, deployment footprint,⁴ risk, flexibility, and sortie generation. In our analyses, we determined the resources necessary to meet the

operational employment objectives—time-phased sortie generation goals. Prepositioning everything at the base from which operations will be conducted minimizes the deployment airlift footprint and timeline required to begin operations, but it also reduces flexibility, adds political and military risk, and incurs a substantial peacetime cost if several such bases must be prepared. Bringing support from the continental United States (CONUS) or a support location near the area of operation, whether in the theater or outside the theater, increases flexibility and can reduce risk and peacetime cost for materiel. However, setting up support processes in this situation takes longer, and the deployment footprint is larger.

There are five basic components of the global infrastructure. These components are FOLs, FSLs, CONUS support locations (CSLs),

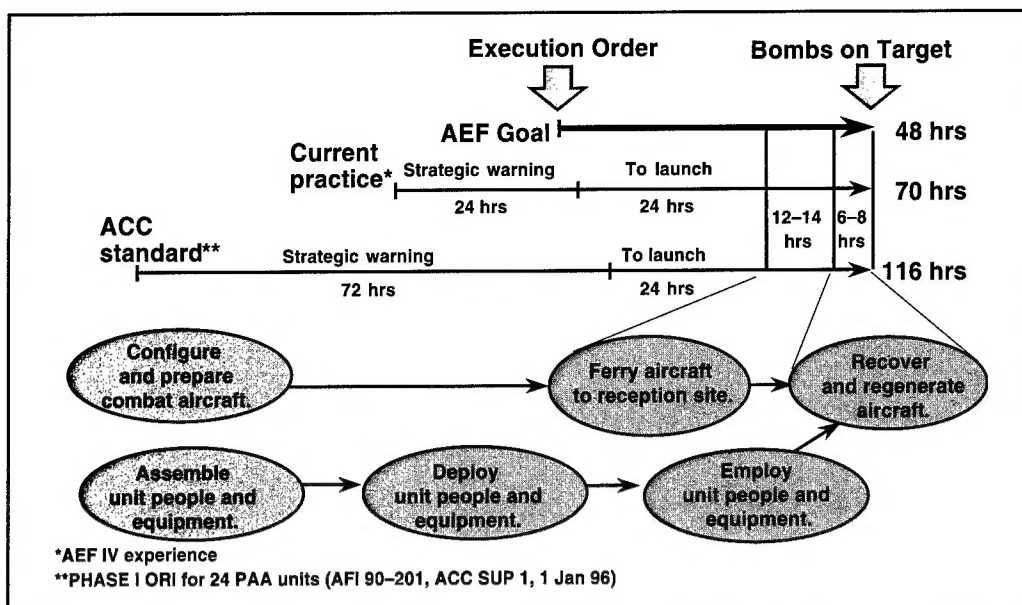


Figure 1. Deployment and Employment Planning

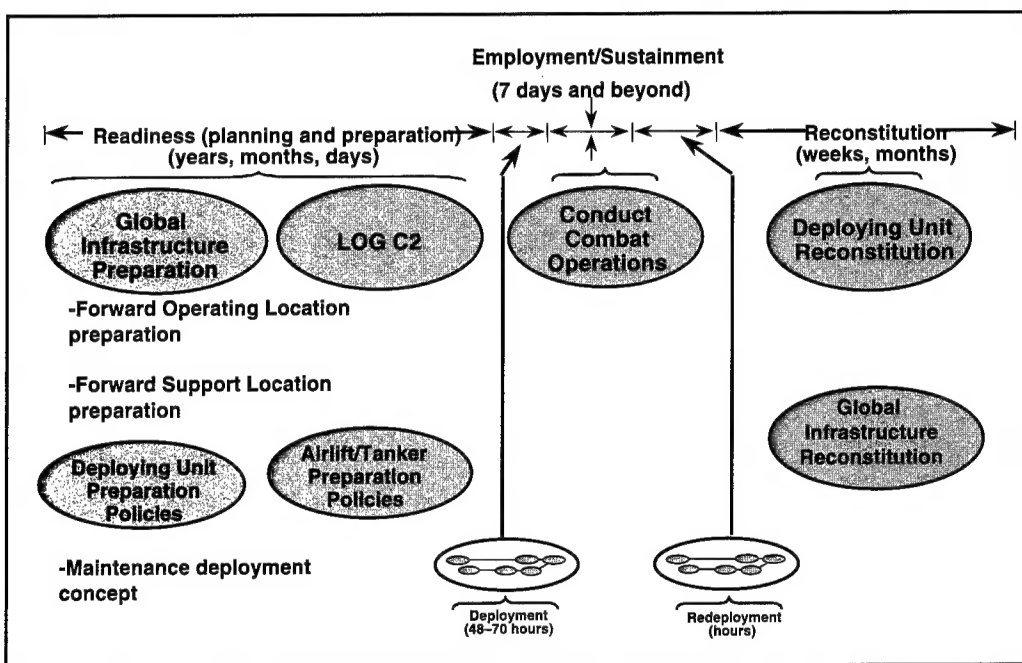


Figure 2. Strategic Decision Relationships

responsive resupply/transport system, and a logistics command and control (logistics C2) system.

FOLs are the locations from which aircraft conduct their operations or missions. FOLs are divided into three categories based on their infrastructure and our derived timelines:⁵

A **category-3** FOL is a *bare base*. It meets only the minimum requirements for operation (runway, fuel, and water) of a small fighter package. Such a base would take almost a week (144 hours) to prepare to support AEW high-sortie generation rates.

A **category-2** base has the same support facilities as a category-3 base plus prepared space for fuel storage facilities, a fuel distribution system, general-purpose vehicles (host nation support or for rent), and basic shelter. It may take up to 96 hours before a category-2 base could support AEW high-sortie generation rates.

A **category-1** base has all of the attributes of a category-2 base plus (1) an aircraft arresting system and (2) munitions buildup and

storage sites already set up and 3 days' worth of prepositioned munitions. Such a base could be ready within 48 hours of the execution order to support high AEW sortie generation requirements.

Each category requires differing amounts of equipment to prepare the base for operations and, as a result, has a different timeline and transportation requirement. As the third and fourth components of global infrastructure, two options were considered for supplying these resources: FSLs in or near the theater of operations and CSLs. An FSL can be a storage location for US war reserve materiel, a repair location for selected avionics or engine maintenance actions, a transportation hub, or a combination thereof. It could be staffed permanently by US military or host nation nationals or simply be a warehouse operation until activated. The exact capability of an FSL will be determined by the forces it will potentially support and by the risks and costs of positioning specific capabilities at its locations. The network of CSLs, FSLs, and FOLs needs to be coordinated to provide the resources necessary in order to meet operational goals.

The fourth and fifth components are assured resupply/transportation and a logistics C2 system to coordinate the delivery of resources to FOLs. If AEWs must deploy with minimum support and depend on resupply from either CSLs and/or a set of FLS, they will need to have an assured resupply link whose responsiveness is aligned with the support that is available at the FOL.

The strategic infrastructure envisioned here will also require a more sophisticated logistics C2 structure to coordinate support activities across FOLs, FSLs, and CSLs connected by a rapid transportation system. These last two components are the subject of current RAND and AFLMA research and are not treated further here.

The global infrastructure, then, is a combination of FOLs, FSLs, and CSLs connected by assured resupply and monitored and controlled by a logistics C2 system. Our contribution in this article is to describe several tools and a prototype of the analysis and planning that the Air Force must do to prepare to deploy quickly under the EAF concept.

General Analytic Framework

To analyze basing structure decisions under extreme uncertainty, RAND and AFLMA developed logistics support models for five major resource categories and used them to assess how requirements

change under different scenarios. These five categories—munitions, fuels support, unit maintenance equipment (the bulk of unit support equipment), vehicles, and shelter—comprise the majority of support materiel for an air operation, as shown in Figure 3.⁶ While these models focus on single commodities, they cut across organizational lines where necessary (for example, the munitions support model covers both munitions buildup and aircraft loading processes).

As Figure 4 illustrates, our models have three components. First is a mission requirements analysis that specifies the critical mission parameters determining each support commodity's requirements based on the mission to be flown. The second component is a set of employment-driven logistics process models to determine timelines to set up the process and the materiel, equipment, and people to establish and operate the process. These models are high-level models created within Excel spreadsheets.⁷ The support options analysis evaluates the performance of alternative infrastructure options in providing these requirements (as an example, prepositioning all munitions at an FOL versus moving air-to-air missiles from the CONUS or an FSL). The results of the model analyses comprise recommendations for infrastructure location, forward or CONUS, as well as changes in policies and technologies. Note the feedback arrows in Figure 4 from both of the evaluations to the mission analysis. Part of the support planning process is to inform operational planners about support feasibility, costs, and risks. In some cases, operational plans might need to be adapted as well.

Expeditionary Deployment Performance

Our analytic method provides quantitative treatment of three key metrics: timeline, deployment footprint, and cost. How well can FOLs with varying amounts of prepositioned equipment support expeditionary operations in terms of timeline, footprint, and cost? What is the comparative performance of FSLs versus CSLs for supplying the materiel that is not prepositioned? Risk and flexibility are more difficult to quantify.⁸ For now, decision makers must judge the quantitative tradeoffs provided by the logistics modeling with the subjective factors of risk and flexibility.

We illustrate this analysis⁹ with some results from a scenario requiring a mission package of 12 F-15Cs, 12 F-16CJs, and 12 F-15Es conducting ground attack operations with guided bomb unit (GBU)-10s (2,000-pound bombs). Figure 5 displays the estimates made with the employment-driven models for six different configurations of FOLs, FSLs, or CSLs (each of three categories of FOL in combination with the two options for supplying the remainder).

Timelines to Deploy to Different Categories of FOL

The timeline to have a given support capability up and running is the sum of times required to do a number of tasks (as an example, deploying people to theater, breaking out the deployed or stored equipment, and so forth). We get deterministic times for accomplishing tasks from either computations by the requirements models (for example, the time to build the first load of munitions) or from model rules that are based on judgment (for example, it takes 22 hours to deploy personnel from the CONUS to the FOL). Some activities can be done in parallel, and in these cases, the time required is the maximum of the longest individual process times. For example, equipment may be moved to an FOL from an FSL and unloaded while unit personnel are deploying. In this case, if the time to deploy the personnel were longer than the time to deploy the equipment and have it ready for use when the personnel arrive, the personnel deployment time would be used to determine the minimum spin-up time for this particular process. The models estimate *pessimistic* timelines by adding to a selected set of tasks a somewhat subjective increment.

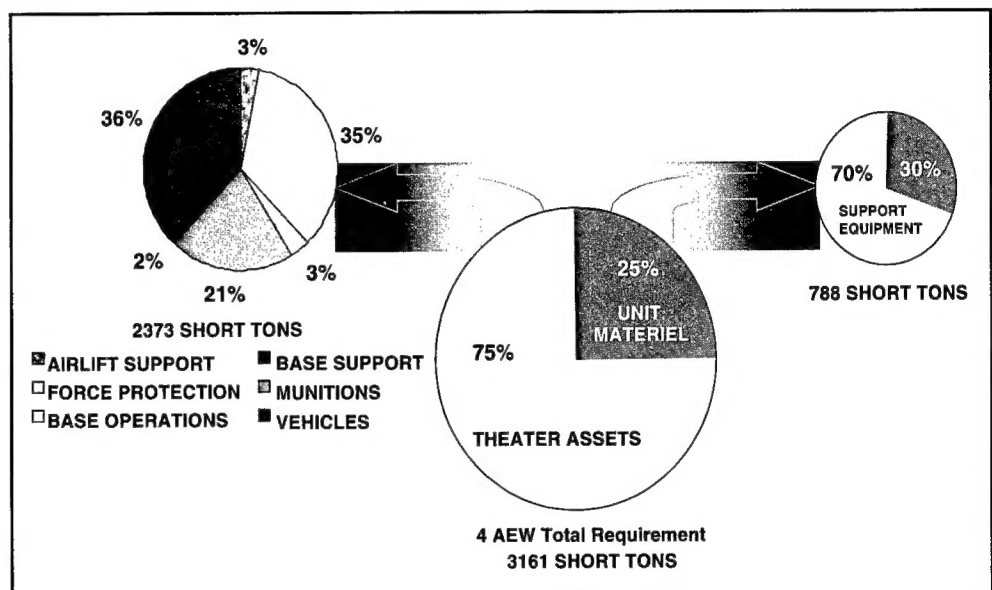


Figure 3. Support Materiel Requirements

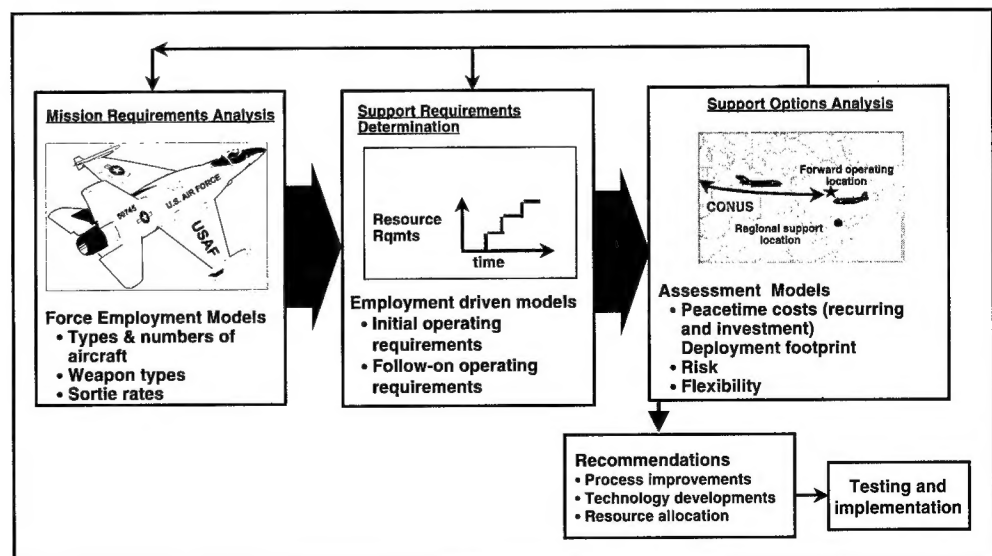


Figure 4. Model Components

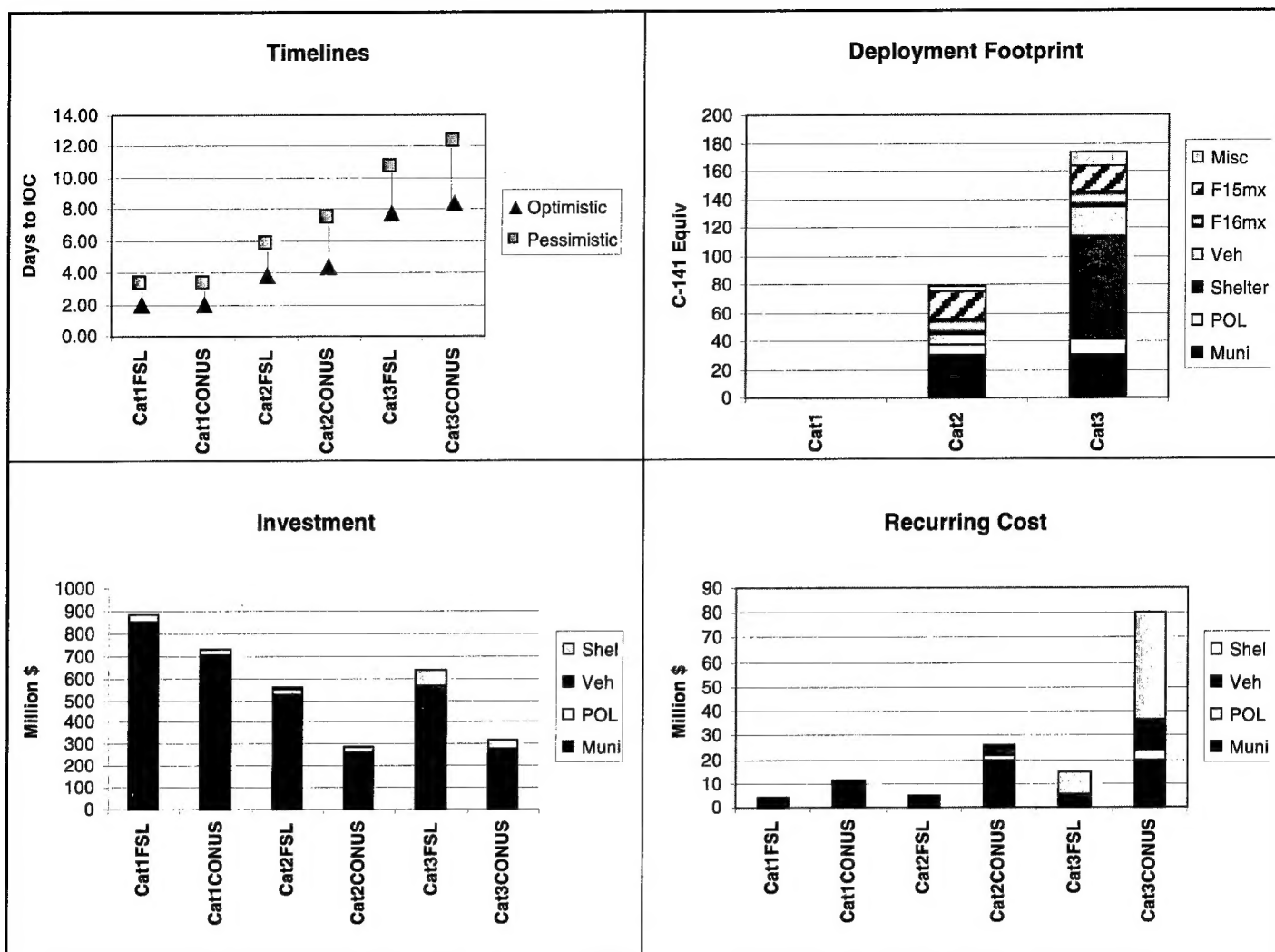


Figure 5. Employment Driven Model, GBU-10 Scenario

We have integrated the timelines for the various commodities by adding the times required to unload the airlift (subject to the maximum on ground [MOG] constraint) and then taking the maximum of that time and all of the other times to set up the various commodity processes and produce the first sortie. This assumes an optimal integration of materiel arrival and process setup and thus is a rough estimate of the optimistic initial operational capability (IOC). For the pessimistic IOC, we use a similar method on the individual pessimistic IOCs for each commodity and its unloading.

The results of the timeline analysis for the three FOL categories are shown in the upper left-hand panel of Figure 5. The optimistic time to set up a category-1 base is just under 2 days, even though most equipment is prepositioned. The time is primarily driven by the time to deploy the people from CONUS and setup times for munitions and fuel storage facilities.¹⁰ For the other options, timelines are driven by the MOG. The difference in timeline between a CSL and an FSL is minimal because the bottleneck is in unloading.¹¹ For category-3 bases, unloading the bulky Harvest Falcon package¹² pushes up timelines.

The bottom line is that meeting the 48-hour timeline will be virtually impossible with current processes and equipment unless most equipment is prepositioned, and even then the timeline is extremely tight.

Deployment Footprint

We define the deployment footprint as the amount of materiel that must be moved to the FOL in order for operations to commence. This

is what we call the initial operating requirement (IOR). The upper right-hand panel of Figure 5 shows the initial footprint for the three categories of bases (the amount of airlift required to get the base operating).

Peacetime Cost Estimates

Current fiscal concerns require that the evaluation of options include the peacetime costs of setting up a given configuration of FOLs and FSLs (*investment*) and the peacetime costs of operating the system (*recurring*). Under our definition, a category-1 FOL will require prepositioning of the IOR of munitions (3 days); munitions assembly equipment; and petroleum, oil, and lubricants (POL) storage and distribution equipment. The equipment then must be maintained for use and be activated for AEW exercises and/or use in a real conflict. If the munitions are to be stored at an FSL for transport to a category-2 FOL, the FSL must contain enough sets of equipment to cover several AEW operations in its area.¹³

The lower left-hand panel in Figure 5 compares investment costs for our scenario for four commodities.¹⁴ The base line configurations are two regions, five bases per region (any one of which might have to support the 36-aircraft AEW), and two simultaneous AEW operations (each central stock location, if any, must be prepared to support two AEWs).¹⁵

As expected, providing for five category-1 FOLs per region is very expensive, and munitions are by far the greatest cost even though minimum IOR (only 3 days' worth) of munitions are prepositioned

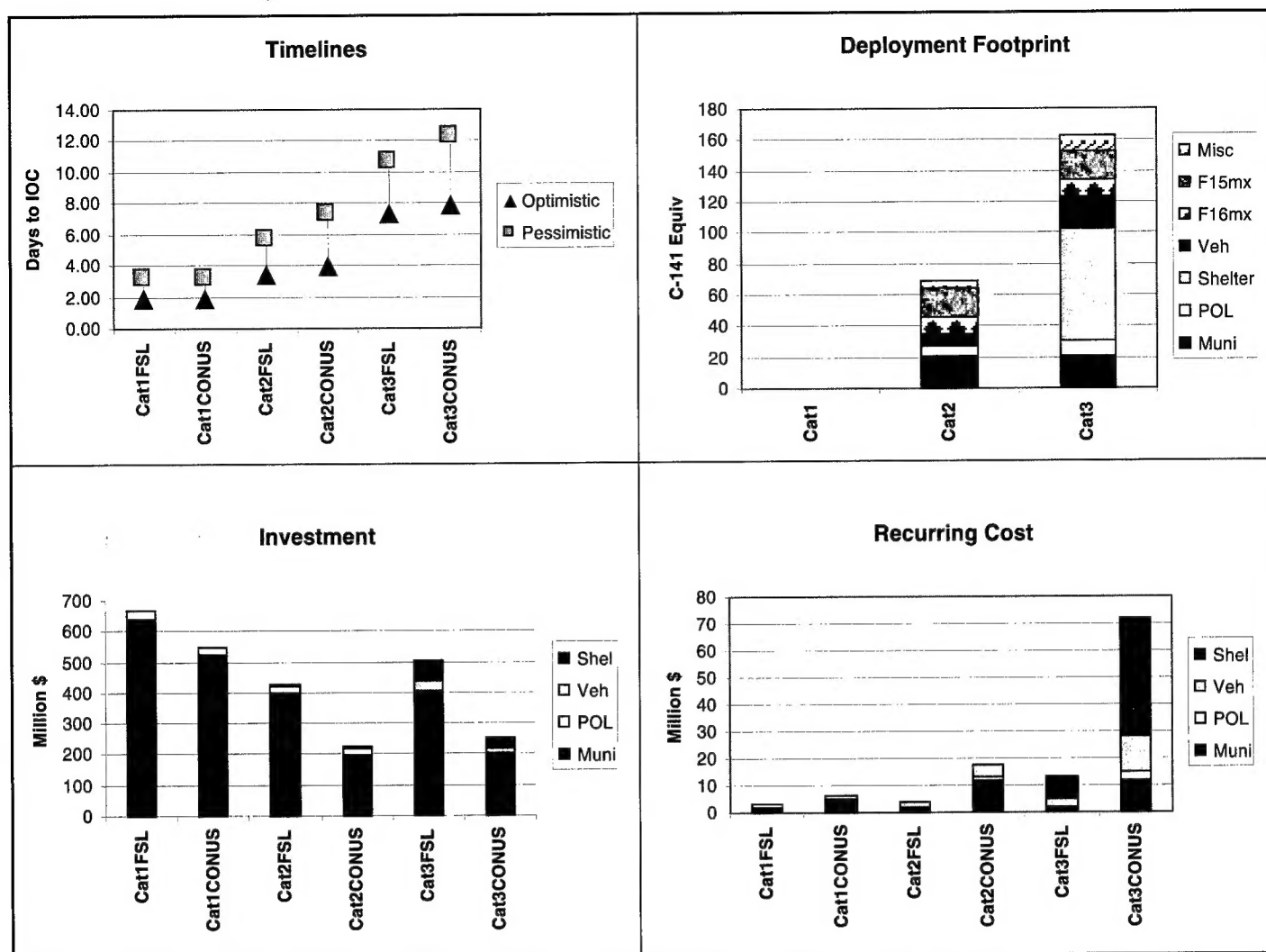


Figure 6. Employment Driven Model, Small Smart Bomb Scenario

at each base. Drawing materiel back from the FOLs decreases the cost, increases flexibility, and (may) decreases risk because each FSL only requires two sets of equipment. However, the deployment footprint increases in terms of the number of transport aircraft needed to move the munitions upon execution of an AEF deployment.

Recurring costs have two components: the transportation cost for exercising AEW deployments and the cost for storage operations. The lower right-hand panel of Figure 5 shows our estimates of the recurring costs for these four commodities for the base configurations. These recurring costs show a different pattern. The category-3 bases supported from the CONUS are very expensive to operate, primarily due to the large costs of transporting munitions and the Harvest Falcon sets twice a year for exercises.

Looking at Figure 5 as a whole, we can see that category-1 bases give the fastest response but at high investment costs. Category-2 bases have a longer response time but at less investment cost, and FOLs have higher investment costs than stockpiling in the CONUS but have lower recurring costs. While the deployment footprint is roughly equal for FSLs and CSL options, the type of airlift differs. Tactical or intratheater airlift could be used to provide resources from FOLs, whereas strategic airlift would be needed to provide the resources from CSLs.

Effects of Different Technologies on Deployment Performance

We can use our modeling to assess the impact of different technologies and policies on support option decisions. We explored

the replacement of GBU-10s with the Small Bomb System (SBS), a 250-pound bomb that is effective against 70 percent of targets for which GBU-10s are used. Because the SBS is much lighter than the GBU-10, each F-15E can carry more of the former.¹⁶ Thus, it takes fewer sorties to deliver the same amount of ordnance. This will in turn reduce POL requirements and, with the right scheduling of sorties, refueler requirements. However, these savings must be weighed against the higher investment costs of using this more expensive munition.¹⁷ Figure 6 captures the analysis of this alternative support option.

The general pattern of each metric seems similar in this case, but closer comparison shows significant differences between the two cases. The SBS option seems to degrade the startup performance slightly because the increased bomb load per sortie requires more bomb buildup work per flight. (If the SBS can be shipped in a full-up configuration, prebuilding the rounds on strategic warning at a storage site may reduce the time to IOC.) As expected, the deployment footprint is somewhat smaller, although the weight of munitions handling equipment is still significant. Finally, the investment and recurring costs are lower for the SBS option. The investment decrease occurs because of fewer missile expenditures. In this scenario, there are fewer air-to-ground sortie requirements and, as a result, lower air-to-air requirements to provide suppression of enemy air defenses and air cover for the air-to-ground operations. The

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THE TECHNOLOGICALLY HOLLOW FORCE OF THE 21ST CENTURY

Colonel Randy A. Smith

Joint Vision 2010 is so focused on the promise of advanced technology, particularly information technology, it is fundamentally flawed and may be a recipe for a new *technologically hollow* force. The very technological breakthroughs that are being used to justify the smaller forces may not materialize because of the shrinking defense budget; overfascination with Advanced Concept Technology Demonstrations (ACTDs), Advanced Technology Demonstration (ATD) and classified *silver bullet* programs; and an unwillingness to confront the overwhelming costs of ongoing military operations other than war (MOOTW).

The Strategic Problem of the Technologically Hollow Force

The USAF Strategic Plan clearly lays out how the Air Force core competencies support *Joint Vision 2010*. The Air Force Strategic Plan indicates that *Joint Vision 2010*'s operational concepts—Dominant Maneuver, Precision Engagement, Full-Dimensional Protection, and Focused Logistics—rely on the contributions of air and space power.¹ Air, space, and information superiority, the Air Force plan argues, enables our forces to operate throughout the battle space creating opportunities to shape battles and achieve war-winning advantages; dominant maneuver by providing freedom for our forces to mass and attack where required without expenditure of excessive resources in preparing the battle space for our objectives; precision engagement with less precise and shorter range conventional weapons, which still make up a significant percentage of our stockpile of munitions; and enables protection of our national assets and deployed forces from attack from any direction or medium, including space and global information media.² Global Attack and Rapid Mobility are the key concepts of the new smaller forces. With declining defense budgets brought about by the Cold War peace dividend and burgeoning social agendas, our military forces are being cut to unprecedented low levels. This includes the loss of personnel, weapons systems, and the closing of bases. If forces are needed overseas, they can be *trucked* in via strategic airlift or *sailed* in via strategic sealift. This concept is one of the fundamental premises of *Joint Vision 2010*'s budget-slashing promise: "... that we will be able to accomplish the effects of mass—the necessary concentration of combat power at the decisive time and place—with less need to mass forces physically than in the past."³ Interestingly, no new strategic lift systems are envisioned for the next half-century while our fighter pilot-dominated Air Force and Navy senior leadership continues the procurement of multiple tactical aircraft systems despite the success of beyond visual range air-to-air missiles and long-range standoff weapons like cruise missiles.

The Air Force core competency Agile Combat Support, like Global Attack and Rapid Mobility, supports the *Joint Vision 2010* concept of Focused Logistics. Again, *Joint Vision 2010* suggests that a smaller, leaner, more lethal force in the future will have a dramatically smaller logistics footprint. This is enabled by an airpower-supported logistics system that will *reach back* to CONUS supplies and commercial sources to get the right part at the right time and get it to the point where needed. Increased reliance upon commercial sources and shippers, like Federal Express, will further justify the elimination of real organic logistics capabilities for wartime support. Information superiority and precision engagement are cited in *Joint Vision 2010* and in *Global Engagement*.⁴ as key enablers of the *Revolution in Military Affairs* used to justify the new technologically hollow force. *Joint Vision 2010* says dramatic advances in technologies—such as long-range precision strike, low-observability, and information superiority—constitute revolutions in military affairs. It further proclaims "The combination of these technology trends will provide an order of magnitude improvement in lethality."⁵ Could an order-of-magnitude improvement in lethality be rewarded with an order-of-magnitude decrease in budget, a new *technologically-based* peace dividend? *Joint Vision 2010* clearly states that the vision "... will be ... difficult to achieve within the budget realities that exist today and into the next century."⁶ It also says we must make "... hard choices to achieve the tradeoffs that will bring the best balance."⁷ Despite all the unfounded rhetoric and promise, the forces will continue to be cut, the modernization budgets will continue to shrink, and MOOTW will continue to consume massive resources and be paid for by further cuts in research and development (R&D) and acquisition programs. The technological basis for the *Joint Vision 2010* vision is like so much of our simulation hype—virtual reality. The reality is unless the defense senior leadership does something to prevent further erosion of the R&D and acquisition budgets we will be living or dying with the new *technologically hollow* force during the next century.

The Strategic Problem of Shrinking Modernization Budgets

The dramatic decline of the modernization budget is a major strategic problem for the Air Force and the nation. From 1986 to 1996, the overall DoD budget has shrunk from about 6 percent to less than 3 percent of the gross national product.⁸ During the same period, DoD personnel strength was only cut 33 percent, thus modernization and R&D accounts took a disproportionate 60 percent cut.⁹ Unfortunately, during the same period of time, the number of operational commitments increased dramatically. Since these operational commitments are not easily planned or budgeted, the costs are born typically by cuts in current year funding for modernization and readiness programs. This has a negative impact

on acquisition programs, causing schedules to slip. The result is increased cost and programmatic risk of the systems. One of the most commonly used measures of cost is the program acquisition unit cost. This cost is calculated by dividing the total cost of the acquisition program (including research and development, concept exploration, product definition and risk reduction, engineering and manufacturing development, production of all systems, spares, training and maintenance aids, and so forth) by the number of articles to be procured in a production configuration. Critics of defense modernization programs commonly use the program acquisition unit cost as the figure. Typically, the number of systems procured decreases as a result of reduced modernization budgets, and when the number of systems procured decreases, the program acquisition unit cost rises. Although the budget may be sufficient to procure the number of systems planned, the perception of unaffordability rises as the program acquisition unit cost increases. The F-22 program has seen dramatic reductions in budget as a result of the Milestone II Engineering and Manufacturing Development (EMD) Defense Acquisition Board Review in July 1991, the Bottom-Up Review in January 1994, the 1997 POM submission, and the Quadrennial Defense Review conducted in May 1997.¹⁰ As a result of these budget cuts, F-22 production has fallen from 750 to 339. The program acquisition unit cost is now more than \$190M.¹¹

The QDR report indicated that . . . funding is adequate to reach the defense procurement goal of approximately \$60B annually, but only as long as infrastructure, manpower and operational reforms are under taken. Thus far, Congress has failed to support more base closings, depot reform and other efficiencies. Consequently procurement will likely languish in the \$50B range, virtually ensuring that all the major systems currently proposed by the services cannot be procured.¹²

The Air Force total obligation authority (top-level budget) has sufficient dollars programmed to procure both the F-22 and the Joint Strike Fighter in the quantities currently planned, but critics assail these tactical air modernization programs as unaffordable.¹³ Even the National Defense Panel, in its December 1997 findings, questioned the cost and future warfighting effectiveness of the F-22, JSF, and Navy F/A-18E/F.¹⁴ The debate should not be over the cost of weapons today—it should be about how we can most cost-effectively field a defense force that will enable us to perform the diverse missions expected of the military in the 21st century with the dramatically reduced manpower, forward presence, and resources envisioned by *Joint Vision 2010*.

ACTDs and Classified *Silver Bullet* Programs: Solution or Problem?

The ACTD philosophy was developed in the late 1980s as a way to speed the infusion of advanced technology into the warfighter's arsenal. The ACTD philosophy was modeled after classified programs like Have Blue, the predecessor to the F-117 stealth fighter. Programs like these were begun during the Carter administration when William J. Perry was Under Secretary of Defense for Research and Engineering.¹⁵ Later, as Secretary of Defense under President Reagan, Mr. Perry institutionalized the concept of ACTDs, and Service science and technology guidance was changed to reflect a new priority for these types of programs.

ACTDs are neither sound business propositions nor good engineering. The concept is to develop a *prototype* system and field it operationally as a silver bullet. If it works and the Services choose to buy more, theoretically they will make a few upgrades to correct problems encountered in the field and have a weapon system. The problem from a business and engineering perspective is the company

with a contract to build one or two prototype systems will be unable to invest the time or resources to accomplish a design and fabrication effort suitable for production or long-term support of a major weapon system. A company cannot invest in production-like tooling or expensive design, fabrication or test equipment if it only has a contract for a few vehicles since it cannot amortize the cost of capital equipment over a large production run. During the YF-22 program, five companies competed, and all lost. These companies invested significant resources in their concept definition programs and fabrication of prototype air vehicles and engines. Although the Lockheed Martin team won the Engineering and Manufacturing Development contract, they will never be able to recoup the cost of their advanced tactical fighter and YF-22 programs. The late Ben Rich, president of Lockheed's Skunk Works, is reported to have said, ". . . our stockholders would have done better financially if they had invested that \$690M in CDs."¹⁶ Other knowledgeable government individuals have indicated the investment by contractors may have exceeded several billion dollars.

Segments of the Services' leadership, DoD, and Congress see the ACTD philosophy as a way to delay modernization decisions and reduce modernization budgets. They say prototype advanced technologies and systems (like the DARKSTAR UAV) and then *put them on the shelf until needed*. However, we need advanced technology to upgrade and/or replace the aging systems that are not militarily effective or that are too expensive to support and maintain in the 21st century. The average age of the Air Force fleet is increasing, and operations and support costs are rising dramatically. "The KC-135 programmed depot maintenance costs increased \$650K per visit in fiscal year 1998, largely due to corrosion and rewiring."¹⁷ Silver bullets and *technology items* sitting on the shelf do not increase our overall warfighting capabilities. In addition, ACTDs and classified programs now consume a significant portion of the Air Force R&D budget. Are funds for other valuable and very needed programs being cut because they are somehow seen as a duplication of classified programs or because there simply is not enough money to go around? A similar problem occurs in public debates when credible facts are not in the public domain. Many comments and damning positions have been published by noted *experts* regarding the F-22, F/A-18E/F, and Joint Strike Fighter. Unfortunately, most of these published positions are based on the limited and often false facts in the public domain and serve only to weaken and confuse the rational debate in DoD and Congress over modernization priorities.

The Overwhelming Cost of Ongoing Military Operations other Than War

In a major RAND study under Project Air Force, Alan Vick, et al. looked at "Preparing the US Air Force for Military Operations Other Than War."¹⁸ Vick's report includes data on Air Force MOOTW from 1916-1996. The Air Force has flown more than 800 such operations. Vick and his team looked at flying hours by aircraft type and concluded ". . . although they represent only 9 percent of USAF MOOTW since 1989, peace operations account for 90 percent of the USAF sorties flown in MOOTW since 1990."¹⁹ Between 1991 and 1995, USAF aircraft flew more than 800,000 hours in support of peace operations with the annual high approaching 170,000 hours. This tasking is particularly high on surveillance and electronic combat assets with 20-35 percent of all sorties flown being engaged in peace operations. This compares with only 5-12 percent of all fighter sorties flown being engaged in peace operations. Specific data by aircraft

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WHERE IS THE BATTLE LINE FOR SUPPLY CONTRACTORS?

Major Susan A. Davidson, USA

In total war it is quite impossible to draw any precise line between military and non-military problems.

—Winston Churchill

Once critical delivery of resupply items is made to the theater of operations, how does it get delivered to the user and who makes that delivery—contracted agencies or the military? This is a question that must be accurately answered for success on the battlefield. As the military continues to downsize, more contracting is being done for critical support missions. In the Army, a major area in which contracting is used is in the delivery and resupply of products and equipment to the users. More emphasis is placed on the ability to get support items delivered to the user within very limited time lines, as opposed to the units stockpiling items in case of need. This concept allows for the unit to focus its assets where needed, lessening the logistical support requirements. However, it requires what has become known as *just in time* logistics—a process through which support is provided as needed, allowing for no surplus and, more importantly, no shortfall. In theory, this system allows for adequate logistical support but does not necessitate stockpiling of supplies or repair parts. Contractors have stood up to this task in garrison very well, but until recently, there has been little guidance as to how far into theater a contractor will be able to deliver goods. The theater infrastructure will determine much of this, but where will the contractor stop, and how quickly can units depend on getting their critical supplies?

The need for augmentation from contractors will not vanish, but the dependability issues must be confirmed for their use to be warranted. The use of contracted agencies must be limited to the position on the battlefield where the current military supply distribution system initiates—at the Theater Management Center (TMC).

Current Peacetime Supply Process

I don't know what the hell this logistics is that Marshall is always talking about, but I want some of it.

—Field Admiral E. J. King

Today, most Army forces and equipment have been withdrawn from forward locations, and the Army is now primarily a continental United States (CONUS)-based force with global responsibilities. The Army has demonstrated through recent force projection operations, such as Bosnia, that it is able to rapidly deploy forces anywhere on the globe. However, it also has been observed that the centralized management of distribution necessary for success within the theater is still a challenge. “Maintaining in-transit visibility and accountability of cargo and efficiently delivering it from ports to the customer with the *right stuff*, to the *right place* at the *right time* still proves to be challenging.”¹

The biggest challenge facing logisticians is keeping up with the force structure changes that are happening as the Army moves toward the *Army After Next* and into a digitized battlefield. The logistics system must move from a supply-based system to a distribution-based system allowing the technologies to progress. The necessity of maintaining accurate, effective, and efficient logistical support remains the logistician's highest goal.

There are three components that comprise the idea of distribution and distribution management: visibility, capacity, and control. All must have reliable, current, and accurate data to be of value to the combatant commander.²

Why is visibility so important? “Visibility is a positive indicator that the distribution pipeline is responsive to customer needs.”³ In fact, distribution managers dedicate most of their work to gaining and maintaining visibility of the various assets, processes, and capabilities throughout the distribution pipeline. Visibility is the most essential component of distribution management. History is full of examples that prove combatant commanders must be confident in the logistician's ability to sustain them.

Visibility is based on a continuum of logistics data from the sustainment base into and through the distribution processes of the distribution system (factory to foxhole). Visibility must begin at the point where materiel starts its movement to the theater of operations, be that a depot, commercial vendor, storage facility in another theater, or war reserve stockpile. The information must be digitized and subsequently entered into the necessary logistics information systems. The next critical element to visibility is the capability to dynamically update that source data regarding the transport, storage, maintenance, or supply status of that particular item/shipment until it is received at the ultimate consumer location. The information must be accessible to all users regardless of the Service or echelon of command requiring the data. Two of the systems available, Joint Total Asset Visibility (JTAV) and Army Total Asset Visibility (ATAV), provide common elements of information on most facets of distribution. The Global Transportation Network provides the transportation update and shipment information directly to Army users or via JTAV/ATAV queries.⁴

These systems allow for the visibility of items from the contractor to the requester; however, once the item is placed into the normal military distribution system, maintaining visibility becomes more difficult. This is primarily due to the level of communication and information systems available on the battlefield. As digitization of the battlefield becomes a reality, visibility issues will change accordingly. The total success of the distribution management system will be dependent upon the quality and interoperability of the logistical information and communication systems.

The second area is capacity—maximizing the logistical capacity of the theater, while not limiting the mobility of the combat commander. The integration of the full range of asset visibility information capabilities and the associated ability to control and allocate resources will permit logisticians to maximize critically limited logistics resources. The ability to anticipate logistics bottlenecks, disruptions, and changes in the distribution operational schema is a key factor in allowing the successful distribution manager to optimize the theater's distribution capacity.

Logisticians work continuously to be able to identify distribution-based problems as they occur. While the Distribution Management Center (DMC) will continue to resolve the distribution management problems, the synergistic intent for this entity is to anticipate distribution needs; provide the necessary resources at the right time; monitor the logistics execution; and as necessary, adjust the distribution system to avoid distribution problems. As decision support tools are developed and introduced into the DMC, more sophisticated problems can be expected and addressed. Until such time, distribution managers must provide much of the fusion and perform the processes to synthesize information across functionally oriented stovepipe information systems.⁵

The third function is that of control and, more importantly, that of centralized control. The DMC must be the single focal point for distribution of logistics on the battlefield. The idea of distribution as a logistical function must be understood at all levels on the battlefield, and proper authority must be given to the DMC to control that distribution system.

The DMC can and must cut through the layers of functional commands and staff agencies to provide accurate and plausible solutions to developing situations that can throttle, disrupt, or stop the essential flow of materiel and units to critical locations on the battlefield. Traditional attitudes and procedures must be put aside for the overall efficiencies and effectiveness of the distribution process. Commanders cannot be permitted to optimize their situations at the cost of suboptimizing the capabilities of the overall distribution system.⁶

In order to understand the critical aspects of control of the distribution system, we must first look at the basic principles of distribution. Eight basic principles are examined and supported through current logistical systems in the Army.

1. **Centralized Management.** Centralizing management includes all aspects of the distribution system being controlled by a single organization. It must include total visibility and control of the entire distribution process from vendor to user. Under a distribution based logistics system (DBLS), designated distribution managers will establish, coordinate, and synchronize the distribution plan and logistics flow and maintain and use this information to resolve critical distribution issues for supported units. The organization assigned this task at the tactical level is the DMC. The DMC is tasked to translate the commander-in-chief's logistics guidance and priorities into a workable theater distribution plan that is linked to the sustainment flow from CONUS. This flow must be monitored through all agencies in the pipeline to be successful.
2. **Optimizing Infrastructure.** Optimizing infrastructure is dependent on the full spectrum of visibility and will allow distribution managers to reallocate/acquire physical and resource network capabilities necessary to meet the changing battlefield requirements. Battlefield contracting, forward-deployed logistic elements from CONUS, or new ways of working with the host nation will be critical to realizing this principle in a DBLS.
3. **Velocity Over Mass.** At the heart of a DBLS is the principle of *velocity over mass*. This principle is improving the flow (speed and accuracy) of materiel, personnel, equipment, and information through the logistical requisition and supply process. This is accomplished in part by the velocity management (VM) program. VM seeks to help implement the change from mass to velocity by addressing some basic issues in distribution: reducing order and ship time and minimizing back orders, reducing repair cycle time, improving stockage determination procedures, and improving the accuracy and timeliness of accounting systems.⁷
4. **Reduced Response Time.** Reduced logistics response time (order and ship time) is the culminated effort of velocity over mass. The key is the right item or person to the right place at the right time and in the shortest amount of time.
5. **Minimizing Stockpiling.** This is necessary as the Army moves from a forward station to a rapid response force. The idea is dependent on the time-definite delivery of resources through the distribution system. It involves the ability to understand the minimum essential amounts of supplies required to initiate operations and the continuous flow of follow-on support and resources necessary to maintain operations once the theater matures.
6. **Maximizing Throughput.** This is a subelement of minimized stockpiling. Throughput distribution bypasses one or more echelons in the supply system to minimize handling and speed delivery forward. This is a key area where supply

contractors will have a role on the battlefield of the future. Direct delivery to the user is done in garrison on a daily basis and must be integrated onto the battlefield.

7. **Time-definite Delivery.** Time-definite delivery is the process of delivering the materiel, equipment, and personnel to the combatant commander at the right time. This principle is key because it builds confidence in the supported unit that the logistics system can support operational requirements and eliminate the need (or perceived need) for the stockpiled stores of materiel that have characterized past logistics operations.⁸
8. **Continuous and Seamless Pipeline Flow.** The principle of continuous and seamless pipeline flow involves the application of all other distribution principles to produce the end-to-end continuum of a DBLS. The integrated combat service support (CSS)/command and control automation and communications networks of the distribution system provide the strategic, operational, and tactical connectivity that allows the distribution management structure the capability to maintain visibility of the flow. This is where the combination of visibility, capacity, and control must come together to enable the total success of the distribution-based system.

The bottom line is the logistics planners with maximum asset visibility, and thus the best distribution management, will be best able to support the combat commander's planning and execution with timely and proactive logistics. This will, in turn, free the combat commanders and their staffs to focus on the combat mission at hand.

Contractor's Role on the Battlefield

The key to success of the distribution system is to have items available to place into the distribution flow at very little or no notice. The Army's most recent operations—Just Cause, Desert Shield/Storm, Restore Hope—though highly successful, revealed shortcomings in the logistics system. The time needed to respond to orders placed from the theater was excessive. Partly because of these operations, a consensus among the Army leaders shows that significant improvement of logistics support is required. In the past, the Army has been able to rely on forward-deployed forces and prepositioning of resources. In the future, a smaller percentage of the force structure will be deployed overseas. The difficulty in predicting where the next operation will occur means less reliance on prepositioning. This means a much greater portion of logistics support will have to come from CONUS.

The current, needing-to-be-changed, logistics system amasses *days of supply* of various commodities in an effort to buffer the system's long resupply times and highly variable peacetime and contingency performance. Part of the reason for this is that the Army's current logistics processes were designed in a period when materiel was relatively cheap and transportation relatively expensive. Now, however, the costs of acquiring major weapon system components have sharply increased, while the costs of transporting materiel have sharply decreased. As a result, old assumptions no longer apply. Policies regarding when it is cost-effective to hold rather than move materiel or when to use premium transportation need to be reexamined. For example, in 1990 the Army Materiel Command had nearly \$60B in inventory above the unit level. Yet, with that entire inventory, too many operational commanders did not have the stocks at the right place and time. Now tight budgets do not permit the buildup of massive inventories. Velocity will have to replace mass.⁹

Responsiveness (the ability to quickly and accurately meet the needs of mission commanders) will be the key to the future logistics system. The customers are the field commanders who have

continuously required a logistical support system that is reliable, flexible, and responsive. They are also concerned that this system must meet the budget constraints and maximize effectiveness. Therefore, logisticians need to analyze current processes and design an improved logistics system that will answer all the customers' needs.

Individuals, in their private lives, are accustomed to customer-focused services to meet their needs and those of their families. They order items of clothing or software from a catalog and get efficient, rapid, and accurate delivery. They go to an auto parts store and are either promptly supplied a part or have it ordered for delivery within 1 to 3 days. Army commanders want the logistics system to offer comparable service at comparable costs. The velocity management initiatives are intended to meet this reasonable expectation.

It will be up to the logisticians in the process to change the culture of the Army, allowing change from the logistics system today to the one of the future. If the Army logistics system continues to do business in the same way, it will continue to get the same results. This is beyond doing more with less or making the best of what is currently available. The Army logistics community must understand and accept the change that improves the responsiveness and efficiency of the Army logistics system. Managers and supervisors at all levels must lead this change. Velocity management is an initiative that examines the current process and identifies areas where improvements can be made.

The critical first step in implementing velocity management is to clearly define the process that needs to be improved. Setting goals requires careful analysis of the base line performance. Accuracy and integrity of base line performance measurements are critical to the establishment of future performance goals.¹⁰

Today, the supply clerks have the ability to go directly to the vendor through the contracting system to get supplies that are not in the military supply system. This is done in several ways. One way is for the unit supply clerk to use a credit card (International Merchant Purchase Authorization Card) given to the unit with a pre-authorized spending level. This is a financial management tool as well as a logistical initiative. This allows contractors (vendors) to interact on a one-to-one basis with the supply clerks and the individual units. Goods are ordered and delivered via the commercial system, bypassing the military system completely. In the CONUS, contractors routinely arrive at the unit's site with the desired goods, offering the best customer relations available. This may not be possible in zones of combat.

Battlefield Logistics

The more I see of war, the more I realize how it all depends on administration and transportation. It takes little skill or imagination to see where you would like your army to be and when; it takes much knowledge and hard work to know where you can place your forces and whether you can maintain them there. A real knowledge of supply and movement factors must be the basis of every leader's plan; only then can he know how and when to take risks with those factors, and battles are won only by taking risks.

—General A.C.P. Wavell

Throughout military history, vital strategic decisions that led to victory or defeat have been influenced by important logistics consideration of how to feed, move, and sustain the troops.¹¹ The recognition of the importance of these decisions has led to more research in the distribution management aspects of logistics.

Distribution management encompasses the organization, doctrine, policy, and training required to implement a distribution-based system. Most challenging perhaps is not the basic implementation of each component piece but the integration between levels so that the system

is truly seamless. Distribution management is a fully integral part of the battlefield distribution concept. Effective distribution management will synchronize and optimize the various subelements of the distribution equation: movement control, nodal operations, materiel management, supply support, and associated technology.

The DMC is the focal point for controlling the continuity of the CSS pipeline through situational awareness resulting from total asset visibility. This awareness permits control encompassing the distribution of materiel, equipment, personnel, and soldier support items. The control provided by the DMC integrates the various distribution functions into a more efficient distribution system. It integrates the totality of strategic, operational, and tactical logistics capabilities to provide reliable, effective, and efficient distribution within the theater of operation.

As command and control elements and their associated support relationship change on the battlefield, the logistics community must keep abreast of these changes. Maintaining these relationships ensures the entire spectrum of the supply system can package and ship materiel directly to units in the theater. This information allows the DMC, control centers, and other elements of support operations to maintain visibility and control of the distribution system. The ability of distribution activities to hold, divert, and redirect unit equipment, personnel, supplies and services, and other support to their ultimate delivery sites depends on distribution managers and commanders knowing who is supporting whom and where they are on the battlefield.

World-class logistics defines agility as "... the competency that sustains world-class performance over time ... and is built upon three key capabilities: relevancy, accommodation, and flexibility."

The Council of Logistics Management describes relevancy as "... the ability to maintain focus on the changing needs of customers." Advocates of change within DoD are calling for an agile infrastructure precisely because future peacetime and wartime scenarios will require the ability to change quickly and affordably in response to technology and threats.¹²

The second capability, accommodation, is described as "... the ability to respond to unique customer requests." In DoD, this is called *support tailoring*, a concept that Joint Vision 2010 endorses. Many observers believe industry provides tailored solutions better than do rigid military services and DoD agencies.¹³

The final capability, flexibility, is described as the *ability to adapt to unexpected circumstances*. Flexibility has been a long-standing requirement of DoD logistics concepts. Warfighters covet the logistics capability to encounter; resolve; and when appropriate, exploit the unexpected emergency or opportunity. Flexibility also is a virtue in mobilization. In industry, flexibility can provide reserve production or distribution power. In the Department of Defense, flexibility can provide reserve striking power, which is the essence of mobilization.¹⁴

Reasons for outsourcing range from cutting costs, time, or resources to gaining access to resources not available internally or increasing research databases. It is important to recognize that each of these reasons, to varying degrees, are attractive areas to review in the Army's attempt to restructure the logistical infrastructure. These coincide with the reasons why the Department of Defense is emphasizing competitive sourcing strategies. Similarly, it is interesting to note that most of these reasons help organizations become leaner, more robust, and thereby more agile. The pursuit of agility through competitive sourcing solutions seems to be a common objective of industry and government alike.¹⁵

But exactly how do competitive sourcing strategies contribute to more agile organizations and processes? The following advantages

of competitive sourcing are particularly relevant to DoD pursuit of a more agile infrastructure. Competitive sourcing will:

- Give the DoD access to a broader range of sources for support and surge capability.
- Speed incentives for internal reengineering (improving processes). For example, the Air Force has been influenced by the leading-edge practices of commercial airlines.
- Reengineer vertically integrated organizations that have grown obsolete, making enterprises smaller, more focused, and more fluid.
- Provide for speedy capture of innovations, which allows technology to be leveraged quickly.
- Gain access to resources or expertise not available internally.
- Permit contracting flexibility for things the government cannot do.
- Allow development of integrated supplier concepts, such as those several commercial airlines are adopting (for example, British Airways and Southwest Airlines).
- Allow lower inventory levels, nimble transportation, and reduced cycle times.”¹⁶

There is no doubt that a partnership is necessary between the government and industry in times of mobilization. History shows few, if any, examples of where the military has been successful without this partnership. However, because it does require total commitment from both agencies, the Army is not ready to abdicate infrastructure management. In the historical context, the private sector had a huge role in assembling, producing, and projecting the elements of infrastructure; however, none of those scenarios involved the degree of private-sector performance, management, and control of defense infrastructure elements being espoused today. Military buyers of infrastructure services should be cautious about relying on contractors, particularly where real-time control is critical. Outsourcing and privatization imply the formation of strategic relationships with external suppliers that will lead to some loss of military control over essential functions. The fog and friction typical of war caution us that losing control could be instrumental to losing the war.¹⁷

Still, there is little doubt that the military must increase its reliance on private-sector providers, particularly to support small- to medium-scale deployments associated with our current geopolitical objectives. Today, many of its infrastructure activities consist of support functions that are not directly related to core military competencies. These functions claim an unaffordable 60 percent of the DoD budget. Yet cost reduction is not the most important reason to use private sector providers of infrastructure services—performance improvement is. Industry has bypassed the military in most areas of logistics support capabilities: responsiveness, innovation expertise, surge and agility.¹⁸

Unfortunately, much energy still is being expended across the military services and DoD agencies (and in Congress) to preserve and protect organic assets that are not essential to defense missions. A better use of this energy would be integrating DoD's and industry's core competencies. Long-term integration of contract suppliers and military buyers will yield the infrastructure agility highly prized during peace, mobilization, and combat.⁹

Future Operations

Commercial practices are being examined by the logistics community to determine where they can be integrated into the military

system. The practices identified as the best practices are the key area of emphasis.

Integrated supply chain management, industry's changing view of logistics, electronic commerce, automated identification technology, direct vendor delivery, load optimization, outsourcing, and smart simple design are all examples of commercial best practices that could be very useful in helping the Army achieve the RML.²⁰

Integrated supply chain management includes the highest levels of suppliers down through the system to the ultimate single customer. Currently, this is being done throughout industry through integrated software systems available at a high initial cost to the industry but recognized as offering future cost savings by tailoring the system to maximize effectiveness.

Electronic commerce is the practice of using the Internet and other electronic technologies and applications to affect the logistics of the system. “Electronic commerce and the sharing of information among entities and organizations facilitates vendor-managed inventories, paperless contracting, collaborative forecasting, and workflow management.”²¹ All these aspects, when put into the military context, will greatly enhance the effectiveness of the logistics system and contribute to battlefield success.

Automated identification technology is simply the technology that allows for the identification of an item of supply through an automated database. The military currently uses it during deployment as major end items are identified with labels read by a scanner that places the item into a database. This allows for load plans of deployment vessels to be quickly assembled and the receiving port to know what is expected to arrive. The commercial industry has taken this one step further and has been able to identify the smallest item and track that item as it transits the logistical system—another benefit the military can use to achieve the total asset visibility required in future operations.

Direct vendor delivery is the direct delivery of items from vendor to customer. This allows the system to bypass needless handling thereby decreasing the order-receipt time. This is also the area where additional research must be done to delineate between the garrison environment and the battlefield.

Load optimization is a software program that plans and optimizes loads for trucks and containers. This ensures full use of the capacity available for delivery to the requester. Ensuring the maximum amount of supplies are loaded on each truck designated for a specific user allows for less traffic on a particular route, thus maximizing the transportation network.

As discussed earlier, outsourcing is done for lower costs, streamlined labor force, access to top personnel and cutting-edge technologies. By partnering with other organizations, a company or the military can increase its service levels and limit response time while maximizing cost effectiveness.

“Smart simple design can be achieved by designing equipment with fewer, standardized parts, at reduced cost, with higher quality, faster manufacture and assembly cycle times, and better serviceability.”²² Decreasing the number of supply items in the inventory, either by combining like type items or by designing new multifunctional items, lessens the workload of the supply system. This, in turn, increases the efficiency of that system.

Additional work in research and development is continuously being done to improve and streamline the logistical system.

The Army must partner with world-class logistics providers when beneficial and become a world-class provider itself by leveraging the best industry has to offer. The challenge is to decide where and when to pursue each of these industry-proven strategies.²³

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Focused Logistics in 2010—A Civil Sector Force Multiplier for the Operational Commander

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The demise of the Cold War, reallocation of fiscal resources, and the kinds of joint future coalition warfare or operations the United States expects to conduct during the 21st century require innovative and creative thinking by America's military leaders. Recently, the Chairman of the Joint Chiefs of Staff issued *Joint Vision 2010* (JV 2010), a document that provides a conceptual framework for America's Armed Forces to think about the future.¹ The premise of JV 2010 is that joint military interoperability, coupled with a strong technological underpinning, will be a key tenet in conducting military operations in the 21st century. The JV 2010 document identifies four new operational concepts requisite in the conduct of future military operations. These concepts are Dominant Maneuver, Precision Engagement, Full-Dimension Protection, and Focused Logistics.²

Historical Foundation

The use of civilian contractors and reliance upon the civil sector in the support of war efforts are rooted in history. During the Revolutionary War, much of the land transport was provided through the contract system of hiring teams and drivers.³ This is one of the earliest recorded examples of civil sector support to an operational commander. In another example, during the Mexican War of 1850, General Jessup, the Quartermaster General, relied heavily upon private transportation throughout the entire war effort.⁴ Prior to World War II, the US military routinely relied on the private sector for much of its support. Former Secretary of the Air Force Sheila Widnall noted:

Lest you think this is a new phenomenon, let me take you back to the era before World War II when private support was standard. It was only during the Cold War when we realized the huge buildup of government operations that we came to think of government support as the norm.⁵

Further, Clausewitz recognized the need for civil sector involvement in the sustainment of forces when he described the ability of the warfighting soldier to *live off* households or the community during battle.⁶

However, the role of logistics in waging war has evolved from the simple requirements of the American Revolutionary War soldier to the complicated and costly logistics requirements of today's modern warrior and machines.⁷

Rear Admiral Henry E. Eccles clearly recognized the need for significant civil sector involvement in his seminal work, *Command Logistics*, when he stated:

We should remember that since the amount of logistics support available to any commander is limited, the commander who utilizes his limited resources most efficiently will have the greatest freedom of action and combat capability.⁸

Efficient use of limited resources in today's environment strongly dictates active and viable involvement of the civil sector with the operational warfighting commander. Thorpe clearly recognizes this fact when he states, "... preparation for war is not complete until the laboring man is prepared for war."⁹

The technological underpinnings of JV 2010 and the Focused Logistics operational concept rely predominantly upon the flow of information back to the operational commander. Sophisticated, technologically advanced computer and information systems are required to not only provide the necessary command and control of the warfighting forces but also identify and ascertain availability of provisions and supplies during combat and noncombat operations (military operations other than war [MOOTW]). Morgenstern recognized this need for the operational commander when he stated:

... the deeper analyses of the problems of military logistics will show that the most difficult and most important aspects lie in the field of information and in the flow of messages and papers.¹⁰

Technology available in the civil sector allows improved means of communication and opportunities for new organizational arrangements.¹¹ These organizational arrangements allow for greater managerial control and improved planning by the operational commander.¹²

Civil Sector Involvement with Military Operations

Civil sector involvement in future military operations as envisioned by JV 2010 is primarily through civilian contractors who do work formerly done by organic military personnel. This concept is called outsourcing, which is defined as the transfer of a function previously performed in house to an outside provider.¹³ Competition by the government with the private sector in performing services that are not inherently governmental in nature has been expressly prohibited since the middle of the Eisenhower administration. *Bureau of the Budget Bulletin 55-4* expressly prohibits such functions:

The federal government will not start or carry on any commercial activity to provide a service or product for its own use if such product or service can be procured from private enterprise through ordinary business channels.¹⁴

Current acquisition policy contained in *Federal Acquisition Circular 90-29* confirms the same basic position:

It is the policy of the Government to ... rely generally on private, commercial sources for supplies and services, if certain criteria are met while recognizing that some functions are inherently governmental and must be performed by Government personnel ...¹⁵

Many studies have investigated the outsourcing process and identified various factors that result in successful outsourcing contracts.^{16,17,18,19,20} As government enters the 21st century, many senior leaders strongly advocate the use of methods and models that are successfully employed in the private sector but have not been applied extensively in a nonprofit environment such as defense. The presumption of efficiency in the private sector is challenged less forcefully, but the challenges rely on theories of noncompetitive markets, examples of malfeasance by contractors, and concerns for

equity when private firms profit from provision of public services.^{21,22,23,24} New, innovative methods and *out-of-the-box* thinking are required more than at any time previously in order to achieve the defense mission with the fiscal resources allocated. Creativity and innovation are the keys in today's resource-constrained environment.²⁵

These precepts are diametrical to the function of a governmental bureaucracy, especially that of the Department of Defense. As the largest bureaucracy in the federal government, change and innovation are not ideas or concepts that are easily embraced by entrenched government bureaucrats. Carnes Lord perhaps best described the dynamics of bureaucracy in his book, *The President and National Security* when he stated:

Perhaps the most powerful factor determining bureaucratic behavior is the instinct of organizational self-preservation. Like all other forms of life, bureaucracies tend to pursue survival before all other goals. Also like other forms of life, they tend to be resourceful in adapting to their environment. Bureaucratic entities are, as a result, notoriously difficult to kill off, even after their original reason for being has disappeared. Organizational survival is inseparably bound up in organizational identity.²⁶

Warfighting *CINCDOMs* represent the best of a long-entrenched bureaucracy. Organizational support paradigms, structures, and frameworks not familiar to the operational commander are inevitable in improving efficiency of operations. JV 2010's *Focused Logistics* operational objective mandates logistics done in a new manner and relies on civilian contractors to provide that support—a tall order for any warfighter to swallow, let alone implement. However, with no organic military resources to rely upon, the civil sector will become paramount in the successful accomplishment of the military operation.

Operational Logistics in the 21st Century

The support provided to the warfighting commander in chief (CINC) is composed of the four pillars identified in Figure 1. The foundation of the entire support structure is civil sector support. As used in this context, various contractors supporting the operational CINC are identified in Table 1.

Commercial contractors may include such well-known US companies as Brown and Root, Boeing Services, and Holmes and Narver—companies that have offices and headquarters in the United States and make a primary business of providing military base infrastructure support and contracted assistance to the American Government overseas. Conversely, foreign commercial contractors could also be successfully employed to provide support to the operational warfighter and may be essential if American contractors are unavailable or unable to perform the tasks required. Third World national contractors may also be employed, as is the case in Southwest Asia where many Third World nationals from countries such as India, the Philippines, and Pakistan are employed to do labor-intensive work.

In each case cited, relationships must be forged that will vary based on the type of contractor. Religious, racial, ethnic, and gender differences are all elements that must be considered by the CINC when determining how the contractor will be used. The CINC's civil affairs staff is absolutely critical in ensuring optimum civil sector support.

The civil affairs staff comprises the next *layer* on the CINC support matrix. This staff possesses the capabilities to not only understand the culture, ethnicity, and religion of the region in which the warfighting CINC is operating but also work with the local native population in obtaining support necessary for the CINC to either conduct MOOTW or warfighting operations. The foundation of

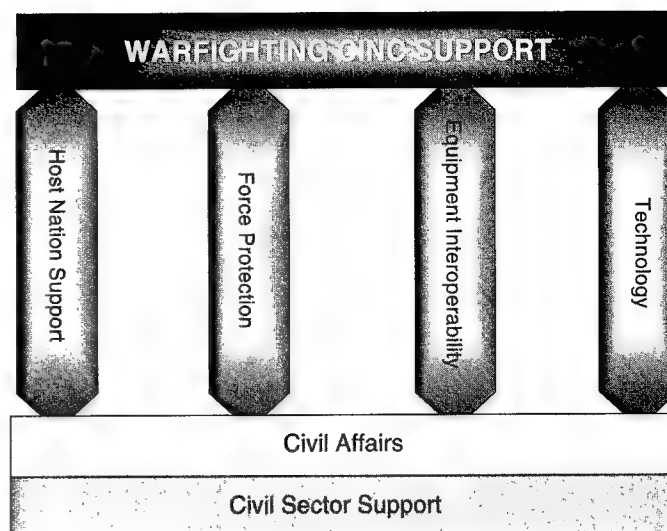


Figure 1—Operational Logistics Pillars

CINC support is composed of both civil sector elements and civil affairs staff amalgamated to obtain any required necessary support.

The four pillars of CINC support are integral to JV 2010's Focused Logistics concept. Coupled with the civil sector and civil affairs support, these pillars provide the integral structure for proper execution of the warfighting CINC's overall objective.

Contractor Type	Location
Commercial	International
Organic, indigent to hostile region	Host nation/nation where hostilities are transpiring
Third World Nationals	Worldwide, Third World Countries

Table 1. Contractor Types and Locations

Host Nation Support

Host nation support will become increasingly critical in the 21st century as we rely upon the civil sector and warfighting coalition partners for much of our warfighting support in both armed conflict and MOOTW operations. With the light, agile, tailored-to-task, readily deployable forces of the future, host nation support will be vital in ensuring that American fighting forces can effectively prosecute any action.²⁷ This host nation support can take the form of supplies, roads, aircraft, aircraft fuel, seaports, piers, overflight and landing rights, and information connectivity into the host nation communications infrastructure. Military civil affairs personnel with specific language skills representative of the region in which the operation or conflict is transpiring will be increasingly vital to the CINC. These native-speaking people will provide the operational commander with insight and understanding.

Force Protection

The most significant command responsibility is the protection of one's troops before, during, and after the hostility period. Nothing is more paramount in this regard than troop or civilian contractor protection. The strong reliance on civil sector support will necessitate that force protection be constant and vigilant throughout the hostility period. Manning augmentation of military protection forces by civil sector contractor personnel is used to protect buildings, equipment,

and vehicles of American combat personnel. The various types of contractors defined in Table 1 can be used for this task. The warfighting CINC must be able to critically assess the risk of using the different types of contractors for the various mission elements. Significant here is the fact that contract personnel from Third World countries may be providing the bulk of the security for American equipment or administrative facilities. This is indeed a distinct paradigm shift from the Cold War era. However, with force reductions, troop drawdowns, and the need to outsource support infrastructure, warfighters will be used in combat operations exclusively. No longer will organic military personnel perform various support functions. Critical to success in the force protection arena is trust between the contractor and the American soldier. This trust may take a long time to earn but a short time to destroy. The CINC must spend significant time and energy ensuring a strong trust develops between the fighting forces and the civilian support contractor personnel.

Equipment Interoperability

The third tenet of the warfighting CINC's support is equipment interoperability. During the Cold War, equipment interoperability specifications for the North Atlantic Treaty Organization (NATO) were common for all member countries. Equipment interoperability is vital in the 21st century where coalitions will be formed to prosecute many of the actions in which the United States may be involved.

The warfighting environment of the 21st century involves both American military forces and coalition forces of other nations. As the United States draws down its overseas force structure and transitions to an expeditionary force based in the continental United States, reliance on the support infrastructure of our coalition partners will be even greater than now. When the height of the Cold War involved equipment interoperability according to standards of NATO, equipment interoperability was much less an issue than it might be in the future. Military personnel were normally responsible for repair, operation, and maintenance of equipment, accompanied by a long logistics support tail that provided parts for any maintenance discrepancy. The Focused Logistics portion of JV 2010 relies heavily upon civil sector support in the theater of operations, generally with support provided by the host nation in which the conflict is being conducted. Significant problems are envisioned by this approach.

The strong reliance that JV 2010 places upon commercial equipment, processes, and procedures strongly dictates that American, European, and Third World equipment have compatibility and interconnectivity. However, this interconnectivity will probably be impossible to obtain. There are not only different standards of operation and sizes of equipment but also differences in such simple things as power sources or the control panel operating language. Interconnectivity becomes an even greater issue when concerned about metric and standard type threads and equipment measurements. Strong reliance upon the civil sector, in theater, may result in failure to rapidly obtain the necessary spare parts to ensure strong equipment viability.

A solution to this problem may be the use of commercial, international equipment instead of military unique or specific hardware. The reduction in support infrastructure and support tail and the use of commercial contractors may diminish many interoperability issues. Civil sector dominance will become increasingly vital to ensuring global coalition equipment interoperability.

Technology

Technology and information science-based civil sector support provide the infrastructure for the operational commander of the 21st century. Commercial technology exploitation has successfully been tested by the Defense Logistics Agency. These technologies include

the Automated Manifest System, in which the manifests of a shipment are contained within a laser card that can be scanned at all points within the delivery cycle, providing up-to-the minute status of the commodity destined for the battlefield. electronic commerce/electronic data interchange—the use of *paperless* transactions for procurement, ordering, delivery, and payment of supplies—is routinely used throughout the world. Premium Service, an analogous service to Federal Expresses' overnight package delivery, has been used in peacetime operations in the continental United States (CONUS). Dedicated truck support is also being successfully used to deliver repair parts to and from the repair depot to the base of utilization. Most of these technologies are currently CONUS based, with plans to use each in a worldwide contingency.²⁸

Each technology described previously will only be as viable as the supporting infrastructure the military has in place. These technologies change rapidly, to the degree that many different software versions or releases may be on the battlefield at the same time. This will become and remain a significant issue for the operational commander. Martin van Creveld recognized the importance of technology when he cited:²⁹

The shorter the war, the greater the importance of weapons and weapons systems. The longer it is, the greater the role of military activities other than fighting, pure and simple, and the greater the role of technologies that impinge on these activities or govern them.

Technology will dominate the concerns of the operational commander in the future. With the many *technology driven* systems that are currently being fielded, a homogeneous system integration of the various technological types will be essential to successful operational battlefield success. Van Creveld recognized systems homogeneity when he identified:

No weapon has ever won a war on its own and without support, clearly some integration is required. On the other hand, there exists a point beyond which integration, regardless of whether it was brought about by the strength of the opposition or by the inherent nature of technology itself will lead to diminishing returns.³⁰

Information warfare and the prevention of information systems disruption must be a real concern of the operational commander's J6. Viruses, *Trojan Horses*, and other data-related disruption agents must be continuously expected with the great dependence upon high-technology information systems. The ability of the enemy to penetrate and disrupt one of the technologically based information systems poses additional security issues. If the enemy is able to successfully remove a space-based asset or its communication up or down link, the operational commander will have no access back to his higher headquarters or other command and control facilities. Contamination or enemy infiltration of the commercial sector support systems may prevent them from providing the operational commander with the required computer systems support. This continues to be an increasingly major concern when relying upon civil sector support.

Conclusions and Recommendations

Will Focused Logistics as envisioned by JV 2010 provide the robust wartime logistics support required by the operational commander? The evidence presented so far is inconclusive; however, it does suggest that JV 2010 is *not in touch* with reality.

The DoD/military culture is conservative, risk averse, and not prone to risk taking. Further, entrenched bureaucracies are highly resistant to change for a variety of reasons. Risk taking will have to

be encouraged if vital civil sector support, as envisioned by JV 2010, is to become a true reality. Large-scale exercises both in CONUS and overseas must be dedicated to the support doctrine espoused by JV 2010 and the Focused Logistics objective. Systems failures must be expeditiously remedied and improvements made. Pilot studies of various sizes, using JV 2010 Focused Logistics concepts and ideas, should be immediately implemented to identify shortfalls and failures. Careful analysis of each pilot study will identify changes required to optimize JV 2010 tenets and objectives. These lessons learned will be vital to all operational commanders, regardless of the theater of operation.

The strong degree of technological dependency envisioned by JV 2010 will not be possible until some *umbrella* architectures are developed for many of the disparate logistics technologies. These *umbrella* architectures must be international in nature and scope, as our dependence upon coalition warfare strongly dictates the United States will most probably use coalition warfare in all hostile engagements.

Contractor force protection, both physical and electronic computer systems, must be carefully planned in critical detail. This is a *knotty* question, for not only must the contractor personnel be protected but also the equipment, supplies, and computer information systems. New concepts must be developed to make this a reality. These concepts must be successfully integrated with operational coalition combat forces, a matter that defies any easy solution.

The JV 2010 Focused Logistics objective is based upon some lofty and highly optimistic technological assumptions that are pervasive throughout the Focused Logistics objective. The DoD Computer-Aided Logistics Support initiative is now approximately 15 years old, but still no unitary international standard or discrete systems architecture has been successfully developed for all combat forces worldwide. Without careful monitoring of JV 2010's Focused Logistics objective, the same problems could plague this idea as well, leaving the operational commander without any real logistics support provided by the civil sector.

Cultural changes and paradigm shifts will be required if JV 2010 and civil sector logistics are to become a true reality.

Notes

1. *Concept for Future Joint Operations, Preliminary Draft*, Fort Monroe, Virginia: Joint Warfighting Center, 21 March 1997, vii.
2. *Ibid.*, vii.
3. David C. Rutenber and Jane S. Allen, ed., *The Logistics of Waging War: American Military Logistics 1774-1985*, Maxwell AFB, Alabama: Air Force Logistics Management Center, February 1991, 19.
4. *Ibid.*, 29.
5. Sheila E. Widnal, Secretary of the Air Force, "Privatization—A Challenge of the Future," Remarks at the Base and Civic Leader Dinner, McClellan AFB, California, 7 February 1996.
6. Carl von Clausewitz, *On War*, Book Five, Chapter 14, 332.

7. Rutenber, 193.
8. Henry E. Eccles, *Command Logistics*, Newport, Rhode Island: Naval War College, 8 February 1956, xv.
9. George C. Thorpe, *Pure Logistics—The Science of War Preparation*, Washington: National Defense University Press, 69.
10. Oskar Morgenstern, *Note on the Formulation of the Study of Logistics*, RM 614, Santa Monica, California: RAND, 28 May 1951, 10.
11. Robert M. Paulson and Thomas T. Tierway, *Logistics and Technology: Some Thoughts about Future Military Implications*, P-4597, Santa Monica, California: RAND, March 1971, 12.
12. Murray A. Geisler, *The Impact of Changing Defense on Logistics Requirements*, P-2845, Santa Monica, California: RAND, December 1963, 21.
13. "Improving the Combat Edge through Outsourcing," *Defense Issues*, Vol. 11, No. 30, Office of the Secretary of Defense (Public Affairs), Pentagon, Washington DC, 3.
14. Bureau of the Budget, *Bureau of the Budget Bulletin 55-4*, Washington: 1955.
15. US Government Printing Office, *Federal Acquisition Circular 90-29, Federal Acquisition Regulation*, § 7.301, Washington DC, 3 July 1995.
16. John B. Handy and Dennis J. O'Connor, *How Winners Win: Lessons Learned from Contractor Competition in Base Operations Support*, Washington DC: Logistics Management Institute, May 1994.
17. Ross Stozenberg and Sandra Betty, *A Pilot Study of the Impact of OMB Circular A-76 on Motor Vehicle Maintenance Cost and Quality in the Air Force*, AF-2829, Santa Monica, California: RAND, 1985.
18. US Department of Defense, *Directions for Defense*, Report of the Commission on Roles and Missions of the Armed Forces, Washington DC: May 1995.
19. Center for Naval Analysis, *Outsourcing Opportunities for the Navy*, CRM 95-224, Alexandria, Virginia, 1996.
20. Mathew R. H. Utley, "Competition in the Provision of Defense Support Services: the UK Experience," *Defense Analysis*, 1993, 9:3.
21. R. C. Moe, "Exploring the Limits of Privatization," *Public Administration Review*, 9:6, 1987, 453-460.
22. J. D. Handrahan, *Government by Contract*, New York: Norton Publishing, 1983, 55-67.
23. H. Brooks, L. Liebman, and C.S. Schelling (eds), *Privatization: No Panacea for What Ails Government*, Cambridge, Massachusetts: Ballinger Publishing, 1984.
24. Robert H. Carver, "Examining the Premises of Contracting Out," *Public Productivity and Management Review*, San Francisco, California: Josey-Bass, 13:1, Fall 1989, 27.
25. Stephen Keava, "Opening the Mind's Eye," *American Bar Journal*, 82, June 1996, Washington DC: American Bar Association, 48.
26. Carnes Lord, *The Presidency and the Management of National Security*, New York: Free Press, 1988, 17.
27. *Concept for Future Joint Operations*, 52.
28. David A. Beckner, et al., *Applying Commercial Practices and Technology to Transportation*, Washington: Logistics Spectrum, 31:2, March/April 1997, 15-17.
29. Martin van Creveld, *Technology and War—From 2000 BC to Present*, London: Brassey's, 1991, 312.
30. *Ibid.*, 281.

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Prejudice against innovation is a typical characteristic of an Officer Corps which has grown up in a well-trying and proven system.

—Field Marshal Erwin Rommel

INSIDE LOGISTICS

EXPLORING THE HEART OF LOGISTICS

JUST THE FAQs—SMART CARDS

Dr. Thomas Gage

What does a smart card look like?

A smart card is basically a plastic card with a computer embedded in it. The standard thickness is 0.76 mm, which is just enough to allow insertion of the computer chip. They look very much like a credit card with small electrical contacts on them (for contact cards). Some cards also have magnetic stripes on one side because they can also serve as credit cards. In others, bar codes appear. Anything can be printed on a smart card.



Is the term standardized or not?

No, although there are *official* definitions. Some insist your credit card, just the way it is, should be called a smart card. Others say only a card with a full-fledged computer in it can be called a smart card. To compound the confusion, cards with computers in them are not always called smart cards. There are several names in use—integrated circuit card, chip card, memory card, and processor card.

How many types of smart card are there?

There are *contact* cards and *no-contact* cards. If the computer communicates directly by means of contacts on the surface of the card, it's a *contact card*. Get rid of the little metal pads, give the computer a tiny radio antenna embedded in the plastic for communication, and it becomes a *contactless* or *noncontact* card. There are also *combi* or *hybrid* cards, which have two computers on them, one that communicates via the contacts and one via the antenna. Some hybrid cards now have one computer that can communicate both ways. There are also *computer* or *processor cards* and *memory cards*. The memory card has on-board memory and a very limited computer that can only put information into an electronic memory and retrieve the data on command. The processor card, on the other hand, has a more powerful computer that can do things such as encode data, check to see if the user knows a required password, and communicate with other computers. Another difference in cards focuses on the way the card is used—*purse* cards versus *security* cards versus *data storage* cards.

Another categorization is how the computer inside the card is programmed—Java versus BASIC versus assembler, for example. There will undoubtedly be yet other types of cards in the future.

Are there standards for smart cards?

The International Organization for Standardization (ISO) has developed standards for smart cards for use by multiple industries.

The basic standard for contact smart cards is the ISO 7816 series, parts 1–10. These standards are derived from the financial ID card standards and detail the physical, electrical, mechanical, and application programming interface to a contact chip card. Some of the standards are still in draft.

Contactless smart card will be governed by the ISO 14443 standard. Details covering the standards can be obtained from the ISO web site: <http://www.iso.ch/>

The EMV (EuroPay, MasterCard, and Visa) specifications can be found at the Visa web site: www.visa.com

Individual industries are now developing their own versions of these ISO standards for their own specific smart card applications, but these are designed to conform to the ISO standards. The goal, of course, is to ensure uniformity.

Where are smart cards being used right now?

The idea of using smart cards has been simmering in government circles for at least a decade. However, there have been significant problems associated with adopting their use. Some feel these problems (lack of interoperability, lack of standards, and constantly changing technology, for example) have been overcome. Some prefer a continual *wait-and-see* approach. Others want the government to rapidly adapt to technology because of the potentially large benefits, especially if multiple application smart cards are widely used.

In 1992, the DoD launched the Multi-Technology Automated Reader Card (MARC). This initiative merged with another military smart card program—the Army's Soldier Readiness Card—and became a military-wide effort under the MARC name. The first user test by the Army began in 1994; more tests followed for the Navy and Air Force. Mike Noll, the DoD MARC project coordinator, noted that six applications were tested for more than 2 years in order to ensure the card met three major goals: cost-effectiveness, durability, and interoperability. "The card certainly proved itself," he said. "We found it was cost-effective for the department, it held up well in the military environment, and users could use the card to download information from one system and upload it into another system." Interoperability was one of the major cost-cutting goals for the use of smart cards. By providing a common platform, data could readily be transmitted into the card's various applications and then be read by common card readers throughout the military. Without this, the DoD would soon face a proliferation of expensive, single-use cards with no compatibility. From a military standpoint, the card can be used to eliminate redundant data entry for frequently

supplied information, such as name, date of birth, address, assignment, and rank. By entering a smart card into a common reader, that information is immediately available, saving time on both sides of the transaction—provider and requester. Since the card can store a lot of information, medical data and histories can be made quickly available to medical personnel, and the data can be updated as patients undergo medical procedures.

The Navy, in conjunction with the General Services Administration (GSA), is the lead Service for smart cards. Smart cards are now being issued to all Navy recruits. They are used to store personnel information such as Service, medical and dental records, Personnel Qualification System, and security access. The card also serves as a room key for sailors staying at temporary quarters. The Navy sees many advantages in using smart cards for multiple applications. By not having to count, store, and move large amounts of cash, for example, their sailors can be more productive. Their *electronic purse* (*e-purse*) will run on the same card with at least eight other applications, including programs that store and process medical and dental records, keep track of sailor training and readiness, and control access to facilities and computer networks. One Navy center has a security gate that uses a handprint identification system. People place their hand on a reader that compares the handprint with an image stored on a smart card, thus eliminating the need for people to memorize personal identification numbers. This same center also has vending machines that operate on smart cards and is using smart cards to track when and to whom tools are issued.

In early March 1998, a yearlong smart card pilot program that also uses fingerprint identification began at Fort Sill, Oklahoma. Eighteen thousand Army recruits received *stored value cards* to be used for \$4M in salary payments, training-related costs, and personal purchases. This is allowing the Army Financial Management Services (FMS) to test the idea and provide recruits easy and convenient access to their pay. To buy something, a recruit inserts the card into a point-of-sale terminal and places the index finger on a biometric sensor that compares the fingerprint to the cardholder's fingerprint stored on the card's microchip. If there is a match, the transaction is authorized, and the cost of the purchase is subtracted from the *cash* on the card. If the card is lost, since there is a name on it, it is easy to return, and the card cannot be used by anyone other than the owner because of the fingerprint match requirement. There are other FMS/DoD smart card pilot projects underway at Fort Knox, Kentucky, and Fort Leonard Wood, Missouri.

In August 1998, 4,200 smart cards were issued to all cadets at the US Air Force Academy. This smart card's initial application is as an electronic purse. The *e-purse* can be used in the laundromats (at the washers and dryers), to make copies in the library, and to buy snacks. Other point-of-sale locations are being added. In addition, academy employees and faculty can buy disposable smart cards. More smart card applications will be added in the future for such things as room access control, medical, manifesting, training qualifications, and test dates.

The Battle Lab at Mountain Home is currently testing a smart card for deployment purposes.

The GSA Smart Card Technology Center recently installed a biometric smart card system using face-recognition technology. The demo is a secure Windows NT log-on system. Here is how it works: the smart card is inserted into a reader attached to a workstation with a video camera. The system finds the image of a face stored on the card and compares it to the image from the video camera. If there's a match, the person is logged onto the workstation and has access to the workstation as long as the smart card is in the reader. Face images that cannot be verified are stored in a time-stamped audit file.

The Seoul Korean Bus Association automatic fare collection system uses contactless smart cards. It is used by 90 different bus companies. In the 18 months preceding April 1998, the system processed 2.6 million transactions per day. Since March 1996, more than 5 million cards have been issued.

Every French Visa debit card (more than 25 million) is a smart card. In Germany, about 40 million banking cards have been issued. EuroPay, MasterCard, and Visa all have smart card programs for their bank members. There are more than 100 countries worldwide that have reduced or eliminated coins from the pay phone system by issuing smart cards.

Various countries with national health care programs are using smart card systems. The largest is the German, which has provided more than 80 million cards to every person in Germany and Austria.

Japan and Singapore are creating entirely new payment systems with smart cards at their core instead of currency.

There are more than 100 million GSM (Global System for Mobile communications) telephones with smart cards that contain the mobile phone security and subscription information. The handset is personalized to the individual by inserting a card, which contains an individual's phone number on the network, billing information, and frequently called numbers.

This year, almost 1 billion smart cards will be produced worldwide by several large manufacturers. Ninety-five percent of these cards will be issued in Europe, South America, and Asia. By the year 2000, *Data Monitor* predicts that more than 3 billion cards will be in circulation worldwide with 15 percent of the total in use in the United States and Canada.

What is a multi-application smart card?

Most of today's smart cards are used for one application: telephone card, cash card, or identification/secure access card. With a computer on board and increasing amounts of memory available, it is becoming more feasible to have one card do several different things—access control to your place of work and your computer terminal, airline ticketing, and serving as cash for trips, for example. While the card can provide a great deal of convenience, it does raise some interesting questions.

With a smart card doing one thing, the card and/or the data on the card belong to the issuer of the card—Visa card for cash, for example. With several applications on one card, that would not seem to make sense. Most of the questions about multi-application smart cards relate not to the technical aspects of the card itself but to relations between people and organizations that provide data and programs to go on the smart card.

However, there are some technical questions regarding the smart card itself. How do you keep data and applications separate from each other? Will getting a library card wipe out the driver's license information? Will a trip to the grocery store wind up in the middle of the last x-ray data? There needs to be some level of assurance all of these separate things will not interfere with each other. Of course, you may want some applications to be able to share data with each other. As an example, you might want the card to be able to share your medical information with the receptionists at the dentist, doctor, and hospital instead of having to fill out forms over and over. There are at least three different ways of handling this:

- **Dominant application supplemented by minor applications.** An example is a mobile phone smart card that allows you to make phone calls but also access your bank account while on the phone. The phone card *runs the show*, but subprograms on the card can retrieve your account information and store it on the card when you call the bank.

This requires cooperation between the provider of the phone card and the bank.

- **Multiple applications under a single specification.** Many applications serve similar purposes and use common information—several different *frequent purchaser* programs or credit/debit cards from different financial institutions or a card that serves as identification for all government functions.
- **Multiple independent applications on a single card, usually referred to as an *electronic purse* or *electronic wallet*.** One company provides the card but does not own or control the card. The person who buys the card owns, controls, and buys applications from separate vendors; for example, a gas card or a credit card. The card itself maintains separation of applications as well as security restricting the applications to their own space and data.

Something to consider when creating multiple applications on one smart card is the problem of losing several things at once; for instance, your drivers license, library card, a meal ticket, and the key to your office. But consider what happens when you lose your wallet today, which probably contains all of the above-mentioned kinds of things, maybe even the key to your office. Replacing a smart card and several applications on it would probably be no more difficult, perhaps less so, than replacing the contents of your lost wallet.

Why don't we see more smart cards in the United States?

Smart cards have been *pushed* for a long time and have found fairly wide acceptance in Europe and Asia but have not really *caught on* in the United States. There are several reasons for this. One of the big contributing factors is the relative cost of telecommunications in the three areas. In the United States, almost any merchant can verify your credit card with a phone call. That phone call is quite cheap, and the merchant can make the price of the phone call part of doing business without significantly impacting the cost to you. In Europe, phone calls are much more expensive, so credit card verification is an expensive business. A smart card, on the other hand, requires no phone call. All of information, security, and authorization required is on the card.

What's the history of smart cards?

The first smart card was developed in 1974 by an independent inventor, Roland Moreno, in France. Inventors in Germany, Japan, and France filed original patents in the 1970s. Because of the immaturity of the semiconductor technology, among other things, most smart card ideas were at the research and development level until the mid-1980s. The French National Visa Debit Card and France Telecom provided some of the first high-volume opportunities.

How much do smart cards cost?

Rough price ranges in US currency: memory card, \$2.40-5.00 per card; protected memory card, \$0.70-4.50 per card; microprocessor card, \$3.50-16.00 per card.

To access the information on these cards, a reader and a connection to a computer that can do something with the data is required. Some (again, very rough) cost estimates: a reader for magnetic stripe cards is around \$750; one for integrated circuit cards around \$500. A reader for the new optical memory cards is around \$3.5-4K.

Keep in mind, though, the card and the reader are often only the beginning. You have to worry about whether you need to alter your existing systems to *marry up* with your new smart card system. If you already have a computerized inventory system and you want people to check stuff in and out via a smart card, will you have to reprogram the inventory system to take data from the smart card reader? That could be the largest cost of all.

How big will the memories on these cards be?

A bit is 1 binary digit, 0 or 1. A byte is 8 binary digits (*bits*), which is equivalent to one text letter. One page of a typical paperback book contains 300 to 500 five-letter words. Most smart cards have been held at a ceiling of 64k bits (that's 8k bytes, 16 paperback pages), but smart cards are making their way to the next level of 256k bits (32k bytes, 64 paperback pages). American Microdevice Manufacturing, Inc., has announced the development of the world's first 4-megabit smart card (1,024 paperback pages). The evolution of smart cards seems set to parallel the evolution of the personal computer—next month's will be larger and faster. How big the memories on the cards will become seems to be limited more by what people will want to do with them than by technology.

Does the computer inside need a battery, and what happens when it runs down?

Generally, smart cards rely on card readers for power, so they don't require their own power. There are some, however, that require small batteries.

How durable are smart cards?

The characteristics of the smart card are part of the ISO 7816, part 1 (physical) and 2 (contact location) standards. Chip location has been a difficult subject, mainly because of the possible presence of magnetic stripes on the same card. The early French cards put the chip module farther off the longitudinal axis of the card than was eventually agreed to by ISO. This was because of the residual risk of chip damage due to bending. The now-agreed-upon lower location does result in higher bending stress on the chip. Experience to date seems to say, however, that this isn't a big problem.

The Navy's experience with smart cards, which is considerable, indicates that they are quite durable and *wash well*. A common occurrence is for a smart card to be forgotten and go through a washing machine. They seem to survive this quite well. An Internet hacker site suggested,

But the most important [thing] is that you find a (smart card) reader with a landing contact socket, and not one with a scratching contact socket. Most vending terminals use the cheap and lousy scratchers. A scratcher will ruin your card in no time. A landing contact socket may be more expensive, but it will not ruin your cards.

A landing socket just comes down onto the contacts and does not scrape across the contacts.

How secure are smart cards?

Most people believe a smart card will at least be more secure than your credit card, because the on-board computer can *defend itself* against attack by someone trying to read the card data or modify the programs. There are several ways for it to do this:

- **Passwords.** The card itself verifies the password, so neither the password nor the process is on somebody's network.
- **Biometrics.** There are some things that are unique to each person, such as fingerprints, the pattern of blood vessels in the back of the eye, the detailed shape of the face, the handprint, the detailed pitch and pattern of the voice, and others. By having the computer in the smart card make matches to these *biological signatures*, passwords won't be needed, and security will be heightened.
- **Encryption.** Encrypting the data on the card or as it is being transmitted or both. In this situation, even if the data is successfully read, it still has to be decrypted. Coming under this heading is the FORTEZZA scheme, which is a

registered trademark held by the National Security Agency. This is a term used to describe a family of security products, both hardware and software that uses a key-escrow scheme of encryption. The keys for decryption are held inviolate unless a law enforcement agency can show why it should have access to the keys.

- **Traditional Security.** Traditional security printing methods (for example, special materials, inks, and patterns), even up to laser-engraving procedures, can be used to prevent copying or rebuilding cards. There are semiconductor features that allow the tracing of each individual chip throughout the whole manufacturing process and prohibit unauthorized access or manipulation of data on the chip. Many control and monitoring procedures can be installed into the entire life cycle of a smart card to prohibit unauthorized access to even elements of a card.

However, the more smart cards can do and the higher their value, the more subject they will be to criminal attacks. Smart cards are highly tamper resistant, but criminals will still try and find the *loophole*. Careless or overly trusting people are the weakest link in terms of security.

Smart card systems have been corrupted by hacker attacks. How much success have hackers had to date?

Not much information is available on the subject, I suppose for the obvious reasons. The companies promoting smart cards do not want you to know whether and how much their cards have been hacked or give ideas to those who have a bent in that direction. The various schemes for keeping cards secure seem pretty effective. The real question is, are those schemes actually implemented as the purveyors of smart cards say they are? You cannot tell by looking at the card. Has the programmer who created the software for your smart card left a *back door* in it, ostensibly for debugging the code, which could then be used to get access for other purposes? You only get the best security with security measures installed in the whole *chain* of usage, not just on the card itself. Even then, some say that continual modernization must take place in order to stay ahead of the attackers.

Are smart cards the wave of the future?

That remains to be seen. Certainly, there are and have been many *pushes* to adopt smart cards in various places. In some places, they have been widely accepted, in others not. The reasons for acceptance or nonacceptance are not always obvious. It is likely they will be adopted where the benefits are clear and obvious to the people involved, in small-scale applications at first. If the benefits of data sharing between applications become compelling, then they will become more widespread.

In a 6 April 1999 *PC Magazine* article, John C. Dvorak said that he believed the reason smart cards have not taken off in this country is US bankers haven't wanted to pay patent royalties for use of the technology and have been waiting for the patents to pass into the public domain. Now that is about to happen, we will see a big boom in smart card business in the United States. Mr. Dvorak believes this will happen in the next 18 months.

Where is all this headed? I mean, how small can computers get and still be useful anyway?

We all know the PC has become more powerful over the last 20 years, and essentially all of the power is because of the size reduction. Before that, computers were large, expensive, and hard to maintain. The idea of putting a computer in a piece of plastic that could be carried in your pocket would have been laughed at by most. Even now, it's difficult to imagine just how small computers actually are, the actual

operating part, that is. It is perhaps even more difficult to imagine how small they are going to be. Some companies are currently trying to figure out how to use individual molecules for the logic elements of computers. This could lead to computers that can fit well inside the confines of a human cell. It may be possible before too many years for today's super computers to fit into your piece of plastic and for other computers to fit into places where we can't imagine using them now.

If I see that smart cards could be useful for my organization, whom do I see?

Smart cards come under the heading of Automated Identification Technology (AIT); the Air Force AIT PMO's web site is at Air Force Materiel Command. www.afmc.wpafb.af.mil/public/HQ-AFMC/LG/LSO/LOA/

You should prepare a concept paper telling how you envision the smart card being used.

Here are some things you should think about:

- Who will use the cards?
- How will the cards be used? Think at least a little way into the future.
- How much and what type of information will be stored on the card?
- What type of security do you need?
- Who will have access to which data elements?
- Which of your departments will have priority access to card capacity?
- Who will be responsible for card configuration, data management, version control, application expansion, card issuance, card updates, card replacement, system operating rules, and information ownership?

Measures can be taken to allow for expansion, reserving memory space, or parts of data fields, for example. Depending on card memory capacity, new data elements can be added to support additional applications. During the card formatting process, sections of the card can be structured to remain open for future additions or can be defined and structured to accept specific data elements.

Card systems should accommodate new applications as the technology improves. A system should provide forward compatibility for new card memory capacity, adding new applications, new key management and encryption standards, and emerging functional standards.

Systems should also include various security mechanisms to control outside access to information on the card. Access can be controlled either by defining who can access the information or how the information can be accessed.

A DoD handbook, *Portable Information Carrier*, was published as MIL-HDBK-0348 on 15 April 1997. This handbook was written for the Department of Defense through the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence. It is to be used for guidance only to assist in the planning and initiation of a single standard for smart card usage across the DoD to prevent separate and incompatible implementation of smart card technologies. This handbook cannot be cited as a requirement, however.

Keep in mind, there are other ways of packaging computers besides plastic cards that look like credit cards; some are now put into rings that can be worn on the finger and are harder to lose.

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The Potential Effect of Cultural Differences in a Culturally Diverse Work Environment

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On the eve of the 21st century, the challenges facing organizations are quite different than they were just a few short decades ago—change has become more rapid and more complex. A recent survey revealed American managers feel that coping with this rapid change is itself the most common problem facing them and their organizations today.¹ Experts tell us that organizations are facing the specific challenges of global competition and see a need for organizational renewal, finding strategic advantage, maintaining high standards of ethics and social responsibility, supporting diversity, and managing the new employee relationships that emphasize empowerment and team.²

Each of the specific challenges mentioned above is impacted by culture. The way these challenges are addressed and resolved can differ significantly from culture to culture. The cultural differences that exist cause people to see the same problem from different perspectives, be motivated by different forces, and arrive at different solutions in resolving a problem. This can be especially significant in situations where there is team emphasis and members are drawn from differing cultures. Understanding and being able to adjust to these cultural differences can affect how the team duties are carried out and its mission accomplishment. A recent survey solicited the views of a group of logisticians from various countries, who are members of an international professional logistics society, to identify cultural differences that might exist between American logisticians and those from foreign countries. The survey instrument was designed to determine if national cultural differences could in any way be reflected in the respondents' conception of the *ideal* job, their internalized values, and the demographics of people in the logistics profession. An understanding of any culturally based differences gives organizations an opportunity to develop a proactive program for preparing its work force to operate effectively in various circumstances. This can reduce anxiety and frustration when dealing with an unknown and culturally unfathomable situation, and it should result in improved performance.

Logistics is an area that extensively utilizes information technology (IT) in the daily performance of logistics tasks. IT is a critical element in the control systems established by organizations to ensure effective performance and efficient use of resources. Advanced information technology has been defined as involving the generation, aggregation, storage, modification, and speedy transmission of information made possible by the advent of computers and related devices.³ More simply, "... information technology refers to any processes, practices or systems that facilitate processing and transporting information."⁴ It has dramatically changed the way people perform their assigned tasks and interact with each other and how organizations are managed. Globalization has resulted in organizations having people and facilities located in many culturally diverse countries. Experts estimate that 25 to 50 percent of an employee's job behavior is culturally determined. Thus, culture does affect perception, performance, and understanding of job requirements. Managing cultural differences can significantly impact how effectively these culturally diverse team members mesh.

Culture is an extremely broad concept because it includes almost all socially learned behaviors. Much of the complex behavior of humans is inexplicable on the basis of innate proclivities and can only be explained on the basis of culture. Simply, culture can be defined as a set of shared ideas or customs, beliefs, and knowledge that characterize a way of life. Sir Edward Tylor, the 19th century British anthropologist, defined culture more fully as that complex whole which includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by man as a member of society.⁵

Culture is behavior learned from others rather than from individual experience. Culture is responsible for most of the personality traits that were once carelessly attributed to race. People become American, Irish, or Korean because they absorb the culture of American, Irish, or Korean society. A society is any organized group of people with a distinct identity, territorial area, and distinctive way of life (a culture). A society is, therefore, nothing more than a group of people with a common culture.^{6,7}

Culture evolves over time in response to the needs of society's individual members. Cultures are not accidental. They are composed of provisions for human biological, economic, and even psychological well being. Culture permits humans to adapt much more readily to various living conditions. Without the benefit of learning passed down from their ancestors, each new generation would have to reinvent societal responses to life's situations and problems. Human beings' almost total reliance on learned behavior, rather than on instinctive behavior, is what makes them different from and superior to other animals.⁸ As time has passed, the patterns of life that we call culture have grown more complex and become the means of adapting to a wide variety of environments.⁹ These are the learned behavioral patterns that people bring with them when they become members of an organization.

An example of how cultural differences in various societies are reflected in their respective societal value systems was provided in a 1993 study by Trice and Beyer. This study examined the distinctive national organizational cultures that have evolved and are currently typical of Japanese and American firms.¹⁰ The differences that have developed resulted from history and geography. Japan's culture is based primarily on Confucianism and Buddhism. It has a history of protecting its borders from foreigners, which has led to homogeneity of the Japanese population and a fear and mistrust of foreigners. The United States, on the other hand, has been influenced by the Protestant ethic, and it has had a history of open borders and heterogeneity. The diverse immigrant groups coming to America have brought with them their unique ethnic and national cultures.¹¹ Table 1 portrays these differences.

Culture at the organizational level is more complicated when a firm operates and draws its personnel from the global environment or finds its personnel working in concert with those of other organizations or nations in a team context on a joint, cooperative effort. The recent trend toward globalization of business makes it imperative that organizations recognize these national cultural differences. If an

Japanese Culture Emphasizes	American Culture Emphasizes
1. Collectivism & Groups	1. Individualism
2. Family & Respect for Authority	2. The Individual & Youth
3. Cooperation & Harmony	3. Competition, Conflict & Confrontation & Differences
4. Patience & Long-Term Results	4. Immediacy & Short-Term Results
5. Humility & Austerity	5. Self-Promotion & Material Wealth

Table 1. Japanese Versus American Organizational Cultures¹⁴

organization is to develop a strong, homogeneous culture, it must find a way to bring its employees under the umbrella of its own unique organizational culture and resolve initial disparities. Organizational culture has been defined as the sharing of philosophies, ideologies, values, assumptions, beliefs, expectations, attitudes, and norms that knot a community together. All of these interrelated psychological qualities reveal a group's agreement, implicit or explicit, on how to approach decisions and problems.¹²

Put a bit more succinctly, organizational culture is the set of shared values that control organizational members' interactions with each other and with suppliers, customers, and other people outside the organization.¹³

Culture at this level provides members with a sense of organizational identity and generates a commitment to the firm's beliefs and values that are larger than the employees themselves. Culture serves two very critical functions for an organization. First, it integrates members so that they understand how to relate to each other. Organizational culture guides working relationships, communications, what constitutes acceptable versus unacceptable behavior, and how status and power are allocated. Second, it helps the organization adapt to the external environment in meeting goals and dealing with outsiders.¹⁵ Organizational culture is critical for the effective functioning of the firm.

In a seminal monumental 1980 study of more than 116,000 IBM employees by the Dutch social scientist Geert Hofstede, he discovered four basic dimensions along which work-related values differed across cultures: power distance, uncertainty avoidance, masculinity/femininity, and individualism/collectivism.¹⁶ Later work by Bond resulted in a fifth dimension, the long-term/short-term orientation. Some of these terms need additional explanation. Power distance refers to the degree to which society's members accept an unequal distribution of power. Uncertainty avoidance relates to the extent to which people are uneasy with ambiguous and uncertain situations. Masculinity/femininity refers to how clearly culture differentiates gender roles, supports male dominance, and stresses economic performance. Individualism/collectivism focuses on the amount of stress put on independence, individual initiative and privacy versus interdependence, and loyalty to the group. Finally, cultures that have long-term orientation stress and emphasize persistence, perseverance, and thrift and pay close attention to status differences, while those that emphasize short-term orientation stress personal steadiness and stability, face-saving, and social niceties.¹⁷ Hofstede used this information to produce some very interesting cultural maps that show how countries and regions cluster together in pairs of cultural dimensions. For example, Canada and the United States are close on the small power distance and high individualism dimensions, while Mexico falls into the area of countries with large power distance and low individualism. In another cultural map, Canada and the United States still tracked very closely together when all five dimensions were considered, and Mexico was still significantly different from them on all dimensions.¹⁸

An important message that comes from Hofstede's cross-cultural study of values is that organizational behavior theories (leadership and motivation, for example), research, and practices from one country

might not translate well to other societies, even ones in close proximity like Mexico is to the United States. For instance, managers from the United States and Canada tend to encourage a moderate degree of worker participation in job-related decisions. This represents the

low degree of power distance valued in those countries. Attempting to translate this particular leadership style to other cultures, like Mexico, that value high-power distance might prove unwise and disastrous. In these high-power distance cultures, people would be much more comfortable deferring to the boss's decision. That would make it extremely unlikely that a very open and highly participative company like Ben and Jerry's Ice Cream could successfully translate its lower power distance approach to all its overseas locations. Similarly, in North America where individualism is stressed, focusing attention on one's own accomplishment is expected and often rewarded in organizations. On the other hand, in more collective South American or Asian cultures, individual success is downplayed, and it would make more sense to reward the group rather than the individual. Finally, in highly masculine cultures, the integration of women into leadership and management positions might require some special sensitivity and timing along with intensive training.¹⁹ One of this study's findings regarding gender differences in the number of female professional logisticians represented in non-American versus American respondents illustrates the point.

Fifty-six percent of Americans believed people worked together when their joint contribution was necessary to accomplish the task, while 57 percent of non-Americans felt that people worked together because the collaboration was personally satisfying, stimulating, or challenging. This indicates that Americans are more task oriented while non-Americans are more relationship oriented. The second question related to legitimacy of control. Fifty-six percent of Americans believed it was legitimate for one person to control another's activities if the role prescribed that the person was responsible for and had authority to direct the other person. Among non-Americans, a majority could not agree on a single answer. Only 43 percent agreed that it was legitimate for one person to control another's activities if the person being controlled accepted the situation in the belief the help or instruction being given would contribute to learning and growth. The indication here is that Americans recognize formal authority related to role or position, while non-Americans recognize direction if the person accepts it voluntarily and perceives it as potentially personally beneficial.

Fifty-seven percent of Americans believed a good organizational member gives first priority to the task's requirements for skill, ability, energy, and materiel resources. Sixty-one percent of non-Americans agreed. The remaining 43 percent of Americans all thought that good organizational members gave first priority to the duties, responsibilities, and requirements of their role and the customary standards of personal behavior, while non-Americans were spread over all the other possible choices. So while Americans and non-Americans are basically in agreement on the importance of task, to Americans, role considerations are almost equally as important. The vast majority of both Americans (92 percent) and non-Americans (93 percent) agreed that the basis for any job assignment should be predicated on the resource and expertise requirements of the job to be accomplished. The differences here, however, occurred in that none of the American respondents thought personal wishes, learning needs, or individual growth should influence the assignment, while non-Americans believed neither the needs or judgment of those in

authority nor the formal division of functions and responsibilities of the system should be considered. Finally, 61 percent of Americans believed organizational success comes to those who are technically effective and competent with an accompanying strong commitment to getting the job done. Fifty-two percent of non-Americans believed organizational success came to those who are effective and competent in personal relationships and have a strong commitment to the growth and development of people.

Table 3 contains the results of the analysis of the survey section on the ideal job. Thirty percent of non-Americans felt higher earnings were the most important characteristic of an *ideal* job, while only 19 percent of Americans felt the same way. Eighty-six percent of Americans felt that having sufficient time left for family or personal life was a very important characteristic of the job compared to only 67 percent of non-Americans. Of far more interest on this section of the survey is an examination of the top five ranked characteristics for each of the two groups. Both Americans and non-Americans placed challenging tasks, making a contribution, working relationships, and freedom to adopt their own approach to the job in the top five, although their specific ranking differed to some extent. Americans did not rank having cooperative workers in the top five grouping, while non-Americans omitted having sufficient time for family and personal life. The most important characteristic for Americans was having challenging tasks to perform, but non-Americans believed making contributions was the primary characteristic. These findings are consistent with those in the values section where Americans leaned toward task and to a lesser extent role, and non-Americans were inclined toward self with some emphasis on task.

The results of the final section of the survey, which solicited demographic information from both groups, are presented in Table 4. Non-American logisticians classified their jobs as managerial in 82 percent of the responses, while only 56 percent of Americans stated that they occupied a managerial role. Again, this is consistent with the fact that many non-American cultures regard membership in a professional society, such as the Society of Logistics Engineers, as a prestige item, and firms will only sponsor and fund management personnel for such membership. Twenty percent of non-American respondents were employed in the logistics field for 6 years or less, while only 11 percent of Americans had this low level of experience. Additionally, non-American logisticians tended to be younger with 61 percent of respondents being 49 years old or younger, while 52 percent of Americans were older than that. A higher proportion of Americans, 92 percent to 83 percent, possessed undergraduate degrees, and 22 percent of Americans held a specialized graduate degree in logistics as

opposed to only 10 percent of non-Americans. In summary, American logisticians were a little older than their foreign counterparts, but they were more experienced, had a higher educational level, and had more specialized graduate logistics training. They were also more likely to be female.

While there are a great many similarities between American and non-American logisticians in spite of their cultural dissimilarities, there are also some significant differences between the two groups. In order to highlight these differences and portray them more clearly and succinctly, Table 5 was constructed. The object here was to present the significant cultural values and beliefs, the key characteristics of the *ideal* job, and the important demographic dissimilarities in one consolidated table so a profile of the most important culturally influenced differences between Americans and non-Americans could be depicted and understood. The inventions, like information technology, that a culture has created or borrowed from other cultures are that culture's technology. Changes that occur in the currently available technology can significantly alter the balance of forces that maintain an existing culture. Media technology has had a major impact on cultures around the world (for example, microchips and software). It has altered and extended sensory capabilities to communicate across time and over long distances. Media are defined as any technologies that extend human ability to communicate beyond the limits of face-to-face contacts. Media technologies influence peoples' perceptions about other cultures and members of those cultures they come in contact with through these media. Media-generated stereotypes have important consequences for the processes and outcomes resulting from intercultural communication.²⁰ Thus, individuals working in a team environment with those from other cultures could experience misperceptions, miscommunications, and misunderstandings because of existing cultural differences. The findings detailed in Table 5 show the differences between American and non-American logisticians that could lead to problems in implementation, utilization, and acceptance of IT initiatives and other types of operations within the organizational context.

The study confirmed that there are significant differences in orientation and motivation based on cultural values. For example, the study results were consistent with the widely held stereotype of Americans. This view portrays American culture as placing a strong emphasis on personal choice and achievement. Hence, Americans are seen as independent, aggressive, and focused on goal or mission achievement. The survey section devoted to values and beliefs demonstrated that task was the primary focus for Americans in all five areas. Thus, Americans seem to concentrate on task in order to ensure that the job gets done and the goal and mission are accomplished.

In contrast, many non-American cultures are stereotyped as placing the heaviest emphasis on the needs, demands, and accomplishments of groups such as families, clans, villages, or countries. In these cultures, the individual defers to the group and its welfare. The study is again consistent with this stereotype. Three of the five belief-and-value areas for non-Americans had a self-orientation with a fourth emphasizing task but with a self-aspect. It is important to remember that the self-questions were constructed so that self-considerations occurred in the context of relationships. Finally, Americans believe individuals should be rewarded and recognized on the basis of personal achievement. This would further explain the task focus results from the study. While some criticize this belief in reward for individual accomplishment and feel it has had a detrimental effect by pressuring people to compete for success, it has encouraged individual talents and skills that may not have been recognized or utilized in more stratified societies. More

Question Stem Related To	Chi-Square Value	Mean
1. Good Boss	.364	.288
2. Working Together	.049	3.34
3. Purpose or Competition	.167	2.76
4. Organizational Conflict	.848	3.15
5. Decision Making	.848	2.78
6. Appropriate Control & Comm Structure	.133	2.91
7. External Environment	.567	3.00
8. Good Subordinate	.311	2.78
9. Good Member of Organization	.085	2.65
10. Treatment of Individual	.116	2.81
11. Control and Influence of Individual	.379	2.80
12. Legitimacy of Control	.046	2.73
13. Basis for Job Assignments	.084	2.94
14. Reason Work Performed	.966	2.62
15. Success in Organization	.087	2.71

Table 2. American Versus Non-American Beliefs

American			Non-American		
Characteristic	Chi-Square Value	Mean	Characteristics	Chi-Square Value	Mean
1. Challenging Tasks	.360	1.69	1. Make Contributions	.268	1.78
2. Make Contributions	.268	1.73	2. Work Relationships	.860	1.79
3. Time for Family	.098	1.84	3. Challenging Tasks	.360	1.88
4. Working Relationships	.860	1.89	4. Cooperative Workers	.315	2.01
5. Freedom to Adopt to Own Job Approach	.432	1.97	5. Freedom to Adopt to Own Job Approach	.432	2.03
6. Cooperative Workers	.315	2.08	6. Opportunity for Higher Earnings	.044	2.06
7. Opportunity for Higher Earnings	.044	2.14	7. Time for Family	.098	2.12
8. Employment Security	.294	2.22	8. Advancement Opportunity	.721	2.19
9. Job Variety	.603	2.25	9. Job Variety	.603	2.33
10. Advancement Opportunity	.721	2.28	10. Be Consulted	.842	2.45
11. Be Consulted	.842	2.41	11. Employment Security	.294	2.54
12. Help Others	.166	2.58	12. Good Working Conditions	.860	2.63
13. Good Working Conditions	.860	2.72	13. Help Others	.166	2.87
14. Serve Your Country	.187	2.83	14. Serve Your Country	.187	2.93
15. Work With Clear Directions	.729	2.92	15. Work With Clear Directions	.729	3.10
16. Little Stress and Tension	.434	3.23	16. Work for Successful Company	.254	3.15
17. Work for Successful Company	.254	3.38	17. Little Stress and Tension	.434	3.28

Table 3. Ideal Job Characteristics Rank Ordering

tradition-bound societies and cultures emphasize group reward for group effort. This, too, is consistent with the study results for non-Americans.

The study concluded that, although there are many similarities between American and non-American logisticians, there are also several culturally based differences. American beliefs and values are heavily influenced by their orientation toward task and to a lesser extent role, while non-Americans are more influenced by self and more minimally task oriented.

The American version of the *ideal* job focuses on time for family and personal life with only minor interest in the opportunity for higher earnings, while non-Americans reverse the emphasis.

American logisticians are more likely to be female, nonmanagerial, more experienced, and better educated than their non-American counterparts.

Successful organizations have learned to blend the values of the headquarters' corporate culture with those of nations that host their overseas operations and from which they draw their personnel. This requires a delicate balancing act. The firm must export its overall corporate culture and philosophy and then tailor it to the local needs, customs, and values of a country. National Semiconductor, a US-based firm, has a very systematic technical decision-making process. However, in Israel, where it has a facility, the culture tends to be far more informal and collective than in the United States. Therefore, in its Israeli operation, the firm has developed a hybrid decision-making process. It is still very systematic, but it incorporates a team-oriented and participative style. This meets the overall corporate cultural need and also respects the existing societal cultural values.²¹ This is not only a wise approach but also a necessary one. Culture can be changed, but it is not an easy process. A phenomenon called ethnocentrism makes it difficult. Ethnocentrism is the belief the customs and practices of one's own culture are superior to those of any other culture.²² Thus, adapting the organization's culture

Category	Chi-Square	Degrees of Freedom
1. Gender and Marital Status	.022	3
2. Age	.490	5
3. Undergraduate Degree	.322	2
4. Graduate Degree	.267	3
5. Professional Certification	.148	2
6. Prior International Logistics Conference Attendance	.924	1
7. Managerial Status	.001	1
8. Type Organization Employed By	.579	2
9. Number of Years Employed in Logistics	.077	3

Table 4. Demographic Data

to existing local cultural differences while maintaining its essential features is a far more sensible approach with a higher probability of success. As the study showed, cultural differences do exist and must be dealt with.

The results of the study indicate that the wisest course of action for any organization that operates in other cultures, has personnel assigned to work with members from other cultures, or has a culturally diverse work force is to explicitly recognize that cultural differences exist and need to be addressed. Personnel need to be able to recognize, understand, and function in a culturally diverse environment. Specifically organizations need to:

- Provide information and training to personnel assigned to a foreign country or work directly with members from other cultures in a team environment.
- Be flexible and sensitive to how existing technology applications, procedures, and uses could affect, conflict with, or alter other cultures.
- Understand and view its operations in the context of the various cultures it or its personnel will operate within.
- Export its overall corporate culture and philosophy to operations in or its personnel participation within other cultures but deftly tailor them to the local needs, customs, and values of each culture within which it or its people operate.

Beliefs and Values	Chi-Square Score	American Orientation	Non-American Orientation
1. Working Together	.049	Task.	Self.
2. Legitimacy of Control	.046	Role.	Self.
3. Good Organizational Member	.085	Task with very strong role emphasis.	Task.
4. Basis of Job Assignment	.084	Task without considering self.	Task without considering role or boss.
5. Organizational Success	.087	Task.	Self.
Ideal Job			
6. Opportunity for Higher Earnings	.044	Only 19% believe it a most important characteristic.	30% felt it a most important characteristic.
7. Time for Family or Personal Life	.098	86% said this was a most or very important characteristic.	67% said this was a most or very important characteristic.
Demographic			
8. Gender and Martial Status	.022	22% of respondents were female.	Only 4.5% of respondents were female.
9. Managerial Status	.001	56% were managers.	82% were managers.
10. Years Employed in Logistics	.077	89% for more than 6 years.	81% for more than 6 years.

Table 5. Summary of Differences

Notes

- Eileen Davis, "What's on American Managers' Minds?" *Management Review*, April 1995, 14-20.
- Gary Dressler, *Management: Leading People and Organizations in the 21st Century*, Upper Saddle River, New Jersey: Prentice Hall Inc., 1998, 7-10.
- Gary Johns, *Organizational Behavior: Understanding and Managing Life at Work*, 4th ed, New York: Harper Collins College Publishers, 1996, 539.
- Management: Leading People and Organizations in the 21st Century*, 614.
- Edward B. Tylor, *Primitive Culture, Vol. I*, London: John Murray, 1891, 1.
- Elbert W. Swart, *Sociology: The Human Science*, 2d ed, New York: McGraw-Hill Book Company, 1981, 67.
- Lewis Coser, Buford Rhea, Patricia A. Steffen, and Steven L. Nock, *Introduction to Sociology*, New York: Harcourt Brace Jovanovich, Inc., 1983, 58.
- Ibid.*, 59-60.
- Sociology: The Human Science*, 69.
- B. J. Hodge, William P. Anthony, and Lawrence M. Gales, *Organization Theory: A Strategic Approach*, 5th ed, Upper Saddle River, New Jersey: Prentice Hall Inc., 1996, 272.
- Ibid.*
- Robert C. Ford, Barry R. Armandi, and Cherrill P. Heaton *Organization Theory: An Integrated Approach*, New York: Harper Row, 1988, 455.
- Gary Jones, *Organization Theory: Text and Cases*, Reading, Massachusetts: Addison-Wesley Publishing Company, Inc., 1995, 168.
- Harrison M. Trice and Janice M. Beyer, *The Culture of Work Organizations*, Englewood Cliffs, New Jersey: Prentice Hall, 1993, 342.
- Richard L. Daft, *Organization Theory and Design*, 6th ed, Cincinnati: South-Western College Publishing, 1998, 368-9.
- Organizational Behavior: Understanding and Managing Life at Work*, 125.
- Ibid.*
- Ibid.*, 125-7.
- Ibid.*, 128.
- Myron W. Lustiq and Jolene Koester, *Intercultural Competence: Interpersonal Communication Across Cultures*, 2d ed, New York: Harper Collins College Publishers, 1996, 74.
- Organizational Behavior: Understanding and Managing Life at Work*, 128.
- Intercultural Competence: Interpersonal Communication Across Cultures*, 85.

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AFI 63-124 PERFORMANCE-BASED SERVICE CONTRACTS

Major Brian Bellacicco

The highly anticipated AFI 63-124, *Performance-Based Service Contracts*, was certified by the Secretary of the Air Force/Contracting. It replaces AFM 64-108, *Service Contracts*, and AFI 63-504, *Quality Assurance Evaluator Program*. The new instruction offers great latitude in implementing performance-based service contracting in order to keep pace with commercial purchasing trends. It applies to most service contracts that are more than \$100K. Some of the highlights include the:

Performance Management Council. Chaired by the installation commander, this executive-level steering group addresses contractor operations effectiveness, budgetary issues, contract management effectiveness, and government/contractor partnering agendas.

Business Requirements and Advisory Group (BRAG). These multifunctional and customer-focused teams plan and manage service contracts throughout the life of the requirement. Some of the duties of the BRAG members include developing business/acquisition strategies, conducting exchanges with industry and other business experts, promoting best value decisions to meet customer requirements, performing market research, participating in source selections, and updating the Performance Management Council.

Flexible methods in developing a statement of work (SOW). To gear more toward commercial practices, SOWs will describe all

(Continued on page 41)



AFMC STUDIES AND ANALYSES PROGRAM

The Air Force Materiel Command (AFMC) Studies and Analyses Office (SAO/XPS), a field operating agency under HQ AFMC Plans, conducts and sponsors studies and research of significant materiel issues. The research provides analytic solutions for improved business practices. Efforts focus on developing and enhancing mathematical models that can relate decisions concerning materiel resources to impacts on business performance and weapon system availability. This enables AFMC to prioritize and justify its investments in resources. The studies and analysis staff works closely with customers in designing and performing studies to ensure there is a healthy balance between the rigorous application of operations research techniques and practical solutions.

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A summary of recent efforts follows.

Execution and Prioritization of Repair Support System (EXPRESS)

EXPRESS is a computational system, database, and network that prioritizes repair and asset distribution actions for Air Force depots. SAO EXPRESS support includes designing system changes to improve the modeling of repair requirements generated by depot-level repair activities and providing the corresponding model changes.

1. **Single Prioritization Across Weapon Systems (SPAWS).** In 1997, the SPAWS technique was developed. SPAWS corrects an EXPRESS deficiency in prioritization across weapon systems and provides EXPRESS with the capability to prioritize depot resupply actions across weapon systems in a manner consistent with weapon system priorities. In 1998,

the concept was presented to various logistics process configuration control boards, which led to approval by the center civilian directors. Following this, work began with the air logistics centers (ALCs) to define the system changes and participate in an extensive development testing effort. The contractor delivered the EXPRESS system changes to the ALCs by year's end for user testing.

2. **Long Flow/Long Repair Study.** ALC users identified concerns about long repair time and long flow time items not receiving sufficient repair priority when repair is very constrained. As a result, a study of alternative methods within the EXPRESS prioritization model was completed. The study resulted in Prioritization of Assets in Repair (PARS) model changes that will be implemented in EXPRESS in September 1999. In a related study, changes were recommended for improving the treatment of high dollar repair items when considering supportability constraints were recommended. A valuable spin-off of these studies was the development of an assessment capability that enables the evaluation of the impact of alternative EXPRESS business rules on weapon system availability.
3. **AFI 63-124 Performance-Based Service Contracts Board of Advisors (BOA) Priorities Policy and Shop Replaceable Unit (SRU) Support.** ALC users were questioning changes in BOA priorities. Their concern was that the BOA priorities had unintended consequences that would degrade SRU support. An analysis confirmed these suspicions, and the Air Staff approved the recommended modifications to the way BOA priorities were being implemented in EXPRESS. While incorporating these changes into the PARS model, the system design was improved by absorbing most of the prioritization functionality resident in other EXPRESS modules.
4. **EXPRESS Planning Module (EPM).** EPM is an EXPRESS-based planning capability that would improve AFMC's ability to successfully meet its daily repair execution targets. Warner Robins (WR) ALC adopted EPM as a Contract Repair Enhancement Program prototype for directing contract repair. SAO provided technical consulting to WR-ALC, the lead ALC, Ogden ALC, and its contractor on those planning efforts that were already under contract. (Analysts: Rich Moore, Karen Klinger, Capt Michel Lefebvre, Curt Neumann, and Bob McCormick)

Retail and Wholesale Stockage Levels for the Air Force

SAO continued to provide Readiness-based Leveling (RBL) implementation support in 1998. This included participating in a number of user meetings with ALC and major command (MAJCOM) personnel and answering many day-to-day questions from users. These activities often led to needed RBL model or policy changes. Many of the model changes were done in cooperation with the Air Force Logistics Management Agency (AFLMA).

A 1997 cooperative analysis with AFLMA helped determine how best to add logic to RBL to set depot retail levels. This major new capability was implemented in January 1998. Another cooperative effort with the AFLMA, Forward-looking RBL, was partially implemented in 1998 with full implementation scheduled this year. Forward-looking RBL will do a better job of setting levels for units that move.

Analysis efforts included an initiative to limit levels by the asset quantity when assets are less than the requirement. SAO developed methods for accomplishing an asset-based RBL computation and attacked the question using analytical and simulation approaches. By

year's end, it had been determined that an asset-based RBL computation does not seem to provide significant benefits in terms of expected back orders over a requirements-based allocation. Smaller analysis efforts looked at the initial stockage support list policy with the AFLMA, D035K Order and Ship Time values, and Requisitioning Objective reporting. (Analysts: Capt Todd May, Bob McCormick, Curt Neumann, and Bill Morgan)

AFMC Logistics Response Time (LRT)

The objective of this study was to provide a way for AFMC and MAJCOMs to monitor customer wait times associated with orders for AFMC-managed items. This will facilitate identification of supply chain bottlenecks. Trend analysis may indicate developing problems or improvements.

As part of the LRT effort, a new system for monitoring LRT for ALC-managed items was developed. This system uses data on closed requisitions to monitor customer wait time by ALC; inventory control point (ICP); product directorate (PD); command; weapon system; priority group; national item identification number (NIIN); and base, with and without depot delay, for both recoverable and consumable Supply Maintenance Activity Group items. The source of the data is the monthly Logistics Metric Analysis Reporting System files from the Defense Automated Addressing System (DAAS). The data are approximately 20 percent complete when received from DAAS. After the SAO software performs error checking and validation, the data are typically approximately 97 percent complete. The new tool is robust and has been fully operational since August 1998. In addition, SAO chaired the AFMC LRT IPT in November 1998 to develop business rules and resolved training issues with the ALCs. A web site was established for disseminating information, trend charts, and databases. The Internet address is <http://www.wpafb.af.mil/hq-afmc/lg/lso/lot>

SAO also provided a way for AFMC and MAJCOMs to monitor customer wait times associated with orders for recoverable Contractor Repair Program, organic, and dual-reparable items from depots as well as aircraft mission capability information. This enables evaluation of contract repair versus organic repair and facilitates trend analysis. Databases and reports are on the Internet.

Additionally, SAO developed a special version of AFMC-LRT that focuses on tracking commercial carrier transportation time. This system enables AFMC to monitor commercial carrier transportation time by carrier, ALC, ICP, PD, command, weapon system, priority group, NIIN, base, and continental United States/outside continental United States. The system became fully operational in September 1998. (Analysts: Capt Thuan Tran, and Mike Niklas)

Bow Wave

Readiness problems related to spare parts shortages were major issues at Corona Fall in November 1997 and were believed to be due in part to funding shortfalls. The AFMC Commander directed the funding requirement for buy and repair backlogs (referred to as the bow wave) be quantified and actions identified that could be taken if additional funding is made available.

SAO evaluated the relationship of serviceable and unserviceable assets to the requirement for these items. Unserviceable assets over and above the depot pipeline requirement were considered the bow wave. The analysis showed it comprised 34 percent of the total requirement. By the end of the year, the bow wave for these items was down to 22 percent. This information was provided by weapon system and command for use by AFMC senior management in reviews with MAJCOM customers.

Additionally, an analysis tool and database to track mission capable (MICAP) hours for the bow wave items was developed. Using this database, aircraft components, engines, and engine parts can be

prioritized by their MICAP hours individually or in total. Also, trends can be observed for individual parts or for a weapon system. For example, F-16s at Eglin AFB were having MICAP problems in 1998. The database made it possible to identify which national stock numbers were causing the problems. (Analysts: Bill Morgan, Vic Presutti, Curt Neumann, Capt Thuan Tran, and Mike Niklas)

Transportation Reconciliation and Certification Tool

SAO developed an automated system to reconcile bank statements and International Merchant Purchase Authorization Card (IMPAC) transactions in Cargo Movement Operation System shipment data. The system can electronically accept, edit, process, and issue reports based on the data it receives. It processes high volumes of data in a small amount of time. Impressed by the prototype, the Army and Marine Corps requested access to the tool to perform their monthly third party billing procedures. This project was part of a larger DoD project to review transportation procedures for using the IMPAC to pay transportation bills. (Analyst: Capt Michel Lefebvre)

Sales Disconnect

Midway through fiscal year 1998, revenues at the Air Force depots were not in proper balance with expenses. The potential to exceed unit cost targets existed. SAO was tasked to quantify differences against projected and actual sales.

It was found that nearly 20,000 aircraft components were projected to have sales of 1.4 million units in fiscal year 1998. This amounted to sales of approximately \$3.5B at fiscal year 1998 exchange prices. Additionally, a \$1.1B projected shortfall was identified, and the disconnect between projected and actual sales for subsequent months was tracked. This information was presented to senior management, and details were sent to the centers for more intensive reviews. (Analyst: Bill Morgan, Vic Presutti, and Curt Neumann)

Reliability and Maintainability Information System (REMIS) Analysis

REMIS is the central database for Air Force equipment. The database currently contains inventory, status, utilization, maintenance, configuration, and time compliance technical orders associated with Air Force aircraft, missiles, comm-electronics, and selected support equipment. SAO provided monthly MICAP rates, total not mission capable supply, not mission capable maintenance, and cannibalization rates for July 1996 to December 1997 for each weapon system to support bow wave analysis. SAO also identified weapon systems that had a significant drop in capability in 1997 and generated aircraft and component data that were used to investigate causes of problem items. (Analyst: Freddie Riggins)

Supply Chain Management Simulation Model

This simulation model is designed to evaluate the readiness implications of alternative logistics support policies under realistic conditions. SAO contracted with the developer of this simulation and used the tool to conduct an analysis of asset-based RBL versus requirements-based RBL. Analysis showed that, when Readiness Spares Package assets and lateral supply are considered, the requirements-based approach provides a higher availability because each base's level is set to its full requirement. This puts more levels/assets at the bases rather than the depot, and there is a higher probability that an asset would already be where it is needed. The simulation model will be used to analyze the impact on aircraft availability for other logistics issues such as constrained repair shop

capacity and modified repair/distribution priorities. (Analyst: Tom Stafford)

DLA Surcharge and Logistics Response Time (LRT)

The Air Force asked for an evaluation of the benefits associated with paying extra to DLA to expedite warehouse time. SAO produced an LRT summary report that compares segment times for expedited (MICAP) and nonexpedited requisitions for fiscal year 1998. The average customer wait time is much better for MICAPs than for other requisitions. However, DLA processing time in the warehouses (O3 segment) accounts for a very small part of the difference. If DLA's surcharge only improves the O3 warehouse time, then the benefits are not worth the cost (spending \$7 million per year for a reduction of about half a day on each requisition). (Analysts: Mike Niklas and Capt Thuan Tran)

Sample Size for Budget Estimates

AFMC wanted a good estimate of computer network service costs but did not want to spend the time or money to conduct a survey at every base. To determine the minimum number of samples needed to obtain a statistically valid estimate of the actual cost at a high level of confidence, SAO developed a spreadsheet model that computes the total number of samples required based on two-phase sampling. This technique uses statistics from existing data to make estimates of the population average with a specified level of confidence. The equations in the model require the population size, precision or interval width, and confidence level. Given this information, the model provides the total number of samples needed for the interval to contain the actual average cost of network services at the selected level of confidence. SAO provided several model results for various confidence levels to give an idea of the range of total samples required. After reviewing the data, a sample size of 56 was used (individual surveys), providing the 95 percent confidence that the cost estimate will be within \$750 of the actual network cost per computer for all AFMC. (Analysts: Tom Stafford and Vic Presutti)

F-229 Engine Study

SAO assisted the Air Force Audit Agency (AFAA) with an analysis of F-229 spare engine/module requirements. The F-229 engine is on the F-16 (one engine) and F-15 (two engines). This engine has had serious logistics support problems. Currently, there is a potential for imbalances in the allocation of resources for purchasing and distributing whole engines and modules. The auditors were interested in applying a readiness-based sparing model to see if supportability improvements or cost savings are attainable. Using the Aircraft Sustainability Model, the SAO staff worked with the auditors to identify how much money is needed, how many new engines to buy, and how many engine spare parts to buy in order to maintain a specified aircraft availability goal. AFAA is using the results of this study to justify its recommendations for changes in spares computation policies for engines and their components. (Analysts: Capt Thuan Tran and Mike Niklas)

1999 Program

In 1999, a major portion of SAO efforts will be directed toward implementing new methods for improving the management of materiel spares. This will include methods to determine requirements, allocate resources, execute support actions, and assess impact. Some specific focus areas are:

- Alternative methods for prioritizing repair and asset distribution support to warfighting squadrons relative to those without war taskings.
- Studies of interest to Air Expeditionary Forces, such as minimizing the deployment *footprint* (shipping weight) for a squadron, given an operational flying requirement.
- Applying the Supply Chain Management Simulation to analyze various algorithms for potential use in Readiness-based Leveling.
- Providing information for weapon system management by integrating databases that depict asset status and constraints.

(Mike Niklas, AFMC/XP-SAO/XPS, DSN 787-6920)



Most Significant Article Award—1998

The Editorial Advisory Board selected "The Political Economy of Privatization for the American Military," written by Colonel R. Philip Deavel, USAF, and "Fightn' N' Stuff," written by Air Commodore David J. Foster, RAF, as the most significant articles published in the *Air Force Journal of Logistics* during 1998.

Most Significant Article Award—Vol XXIII, No. 1

The Editorial Advisory Board selected "Transforming Enabling Processes: The Next Step in Logistics Reform," written by Colonel Arthur B. Morrill III., USAF, and "Competitive Sourcing and Privatization: An Essential USAF Strategy," written by Lieutenant Colonel Stephen E. Newbold, USAF, as the most significant articles in Volume XXIII, Number 1, issue of the *Air Force Journal of Logistics*.

To What Extent Were Logistics Shortages Responsible for Patton's Culmination on the Meuse in 1944?

Air Commodore Peter Dye

Introduction

On 31 August 1944, the leading elements of General Patton's Third Army crossed the Meuse at Commercy and Pont-sur-Meuse while, 30 miles to the north, a task force entered Verdun some 200 days earlier than had been anticipated.¹ In the month since it had been declared operational, the Third Army had swept across France in a remarkable demonstration of aggression, manoeuvre, and fighting power. At this very moment, having hotly pursued the retreating German Army for more than 350 miles, Patton's mood changed from euphoria to frustration and then to despair as his armour ground to an abrupt halt for want of gasoline. In Patton's view, the failure to deliver the fuel needed by his divisions would ensure, "... hereafter many pages will be written on it—or rather, on the events that produced it."²

Allied Strategy

When the Allies landed in Normandy on 6 June 1944 (D-day), they did so on the basis of a detailed campaign plan that envisaged a steady buildup in the beachhead, followed by a breakout and pursuit of a German Army that would use successive river lines to conduct a fighting retreat across France. It was estimated that by D-plus-90 the general Allied front would be along the line of the Seine. Operation Overlord, the Allied invasion of Northwest Europe, theoretically ceased at this point, but the planners at Supreme Headquarters Allied Expeditionary Force (SHAEF) had examined how the war should be prosecuted beyond the Seine. The favoured line of action was a broad front with the main effort to the left threatening the Ruhr, the industrial heart of Germany, with another thrust toward Metz, both efforts joining in the general area of Kassel, following which it was expected resistance would crumble and Germany would surrender (on D-plus-360). The details of these plans are less important than the strategic thinking that lay behind them. This would later weigh heavily in the decision to halt the Third Army at the Meuse. Just as important, it was on this modest timetable (as events were to prove) that the logistics planners based their support arrangements.

Logistics Planning

While SHAEF dealt with strategic and planning issues, it had been agreed that logistics would be handled on a national basis. Rather than serving to simplify matters, this resulted in a complex, if not Byzantine, support organisation for the American forces in Normandy. Overall responsibility for seeing that the First and Third Armies of the Twelfth US Army Group (TUSAG) received the supplies they required lay with the Communications Zone (ComZ). ComZ had originally been formed as the Services of Supply (SOS) in 1942, but from its very existence, disagreement arose about whether the SOS, rather than theatre headquarters should control logistics—a source of contention that was never satisfactorily resolved. Although logistics planners for Overlord remained a SHAEF responsibility, ComZ created two organisations—the Forward Echelon Communications Zone (FECZ) and the Advance

Section, Communications Zone (AdSec)—to assist the combat commands in their own logistics planning. Thereafter, AdSec was destined to handle all logistics activities on the Continent until such time as sufficient assets were in place for FECZ to assume control, pending arrival of the ComZ. Unfortunately, the relationship between FECZ and AdSec was never made entirely clear, nor that with TUSAG. The inevitable result was a great deal of infighting prior to the landings and confusion, if not disarray, thereafter.³

Beachhead Logistics

Drawing on the experience gained in the Mediterranean, the logistics arrangements for Overlord dealt at considerable length with the challenge of landing stores over open beaches. Detailed, comprehensive, and often innovative plans were produced to ensure the necessary stores and consumables—such as POL, ammunition, and rations—would be available to sustain operations. Great care was taken to assess the likely fuel usage, but the real issue was one of distribution. It was concluded that, while packaged fuel (primarily jerricans) would suffice to meet the needs of the assault force, any hope of sustained operations rested upon the provision of bulk distribution.

In the event, much of the pre-invasion logistics planning failed to survive contact with reality, forcing a significant degree of improvisation once Overlord was underway. By the end of D-day, only a few tons of stores had arrived on the American beaches, although over the next few weeks the situation greatly improved. While the heavy storms later in June did immense damage to shipping and the artificial harbours, they did not greatly slow the buildup of stores in the beachhead. At the end of July, nearly 100 percent of the planned cumulative tonnage of stores had been successfully landed (918,000 tons compared to a planned 986,000 tons) as well as 104 percent of the vehicles and 86 percent of the troops. Distribution remained a weakness, and shortages undoubtedly existed, particularly in ammunition, but overall, the beachhead logistics operation had been a success.

The vital contribution made by logisticians to the overall success of Overlord has been stressed in numerous histories, including Eisenhower's own report.⁴

However, as Steve Waddell has pointed out, a careful and painstaking planning process is no substitute for flexibility. In his opinion, the success or failure of the invasion lay in the ability of the logistics planners to cope with two interrelated issues: the armies' long-term supply requirements (beyond beachhead) and the necessary changes to these plans as the campaign progressed.⁵

Breakout Logistics

As the operational tempo rose through July and August, the logistics system was put under increasing strain. A related problem was the need to increase port capacity before winter made the Normandy beaches unusable. The Overlord planners had proposed

to make up the shortfall by opening the Brittany ports and developing facilities in the Quiberon Bay area—Operation Chastity.⁶ The success of Operation Cobra caused the abandonment of the plan in favour of pursuit of the remaining German forces in France, a decision that some argued was the direct cause of Patton's subsequent supply problems.⁷ Thereafter, support to the advancing armies was entirely dependent on the logistics infrastructure and stockpiles built up in the beachhead (in early September, these still comprised 90 percent of all stores on the Continent).

Until 25 July, the distance between the depots and the front line was generally less than 25 miles. Once the breakout was under way, the stress on the distribution system increased as a function of distance. Fuel became the overriding problem, although the availability of rations and spare parts was also of increasing concern. Paradoxically, while the Germans were in full retreat, ammunition was not an issue. During the pursuit across France, the Third Army consumed 350,000 gallons of fuel every day, while between them, the Allied armies required some 800,000 gallons. Sufficient stocks had actually been built up on the Continent to meet these needs; the problem was to move the fuel and other critical stores over distances that grew longer as each day passed (for example, the time needed to deliver gasoline doubled from 12 hours in mid-July to 24 hours by mid-August).⁸

There was firm evidence as early as 22 August that ComZ was unable to meet this challenge and that logistics shortages might threaten the onward progress of the First and Third Armies. Until 18 August, the fuel situation had been manageable, but by the time the Seine was crossed on 23 August, ComZ was having great difficulty in sustaining more than 1-2 days' reserve of both fuel and rations. To overcome the shortfall, the Red Ball Express was created on 25 August to truck supplies in an around-the-clock shuttle between the Normandy ports and the front line (a round-trip that eventually stretched 700 miles). This staved off the imminent crisis, but the relief was short-lived and only gained at considerable cost. Three newly arrived infantry divisions were stripped of their vehicles to help find the required 6,000 trucks that, in turn, consumed 300,000 gallons of fuel each day, sufficient for a field army. In effect, the Red Ball Express represented a calculated gamble that war would end before the trucks wore out.⁹ Even the Allied air forces were drawn into the unequal struggle. Some 11,000 tons of supplies were brought forward by bomber and transport aircraft in the period up to 25 August. On 27 August, more than 25,000 gallons of fuel were delivered by air to the Third Army. Commendable as they were, these measures were simply inadequate to sustain normal consumption rates.¹⁰ Strenuous efforts were made to utilise the French rail network, but the impact would not be felt before the end of September. Even slower, was the progress with the POL pipeline from Cherbourg, which meant most of the gasoline delivered to the advancing armies would remain in packaged form.

Patton was clearly aware of these developments and had cause to discuss the supply situation with General Bradley, TUSAG Commander, on 23 August, although neither of them seems to have been unduly worried about the implications.¹¹ This provides some support for the suggestion that Patton was largely indifferent about logistics, a point made by Van Creveld, who adds that Patton only saw his headquarters logistics staff officer twice during the 1944-45 campaign.¹² In Patton's defence, it has to be remembered that throughout August the SHAEF planners had repeatedly claimed the critical supply situation that would prevent TUSAG from advancing any farther, only to see such predictions rapidly confounded. The army commanders could be forgiven for believing the logisticians had cried wolf too often. When the seriousness of the situation dawned on 29 August, the Third Army staffs were dumbfounded.¹³ On the previous day, when the amount of gasoline received was markedly short of the daily consumption, General Gay, Patton's chief of staff,

wrote in the *War Diary* that it caused "... a small bit of anxiety for the time."¹⁴

Culmination

From 31 August, Patton received increasingly less fuel, such that, by 2 September, the entire Third Army was ineffectively at a standstill. The hiatus ended on 5 September, but the subsequent campaign was far less mobile in nature in the face of strengthening German resistance and continuing supply shortages. Although the fighting would continue until November, Patton was denied his ambition of reaching the Rhine and the possibility of ending the war in 1944. When the Third Army's tanks had first reached the Meuse, the forces defending Lorraine amounted to only nine infantry battalions, two artillery batteries, and ten tanks. The pause in the offensive enabled the Germans to reinforce and organise, effectively denying Patton the opportunity of sweeping through Lorraine unopposed. One of his staff officers wrote (in an account titled, *Stopped, But Not by the Germans*):

If we could possibly have been reinforced in early September ... and could have been continued priority on supplies, we felt that our intrepid troops could have dashed through the Siegfried Line, cut north through Germany and come up on the rear of the German divisions ...¹⁵

Indeed, this is exactly what the Germans feared would happen:

During August 1944, we often wondered why the enemy command did not immediately push forward towards the east across the Moselle, in the Metz area ... to our great surprise the operations of the Allies came to a full stop in front of the West Wall: supply difficulties were presumably at the root of this.¹⁶

The Culprits

Not surprisingly, Patton was the first to point the accusing finger, "... the delay was due to a change of plan by the High Command, implemented, in my opinion, by General Montgomery."¹⁷

He also mentioned three other culprits: the diversion of airlift to the task of feeding the Parisians; the withdrawal of transport aircraft to support Operation Market Garden; and the decision to move ComZ headquarters from Normandy to Paris, diverting several truck companies from the Red Ball Express in the process.

Looking at these issues in turn, there is no doubt that Montgomery was keen to see the Allies pursue and advance into northern Germany and the Ruhr, but this was entirely in keeping with the strategy previously agreed upon. The dilemma that Eisenhower faced arose because of the limited logistics resources at his disposal. This forced him to deny Patton the opportunity of advancing rapidly into Lorraine, rather than crippling the main advance toward the Ruhr. It seems clear that with adequate supply Eisenhower would have strongly supported Patton, as he did once the situation had improved.

As to the diversion of effort to feed Paris, it is difficult to see what else could have been done. The plan to bypass the city, while no doubt operationally sound, was politically naive. Once Paris had been liberated, its citizens had to be fed, even though the impact of providing relief supplies was significant. On 29 August, ComZ was authorised to divert 1,500 tons per day to Paris regardless of the cost to the military effort.¹⁸ It was doubly unfortunate that this coincided with the withdrawal of transport aircraft, although the deficiency was to some extent offset by the employment of bombers. More to the point, over the entire period of the airlift (from 19 August to mid-September), only an average of 500 tons per day was delivered to TUSAG. A great deal more was expected, but the failure to achieve this was as

much due to inexperience, poor procedures, and inadequate planning as to competing operational priorities.

The official historian concludes,

... these deficiencies plagued the operation ... and demonstrated that supply by air demanded the same high degree of advance planning and synchronisation of effort that any other logistic activity did.¹⁹

On the other hand, the decision to relocate ComZ to Paris after only 3 weeks in theatre seems entirely unwarranted. Eisenhower certainly felt so, but it proved impractical to reverse the move once underway. General John C. H. Lee, ComZ Commander, appears to have been a difficult man to work with. His nicknames included *Jesus Christ Himself Lee* and *Garbage Can Lee*. Many of his colleagues regarded him as a martinet with an inflated sense of his own importance (to the extent of having his own personal train). However, as has already been discussed, the problems with the US Army logistics organisation went well beyond the issue of personalities. Optimised to support a relatively gentle advance to the Seine by 12 American divisions at D-plus-90, the logistics plan was simply inadequate when faced with the challenge of supporting 16 divisions operating more than 100 miles beyond Paris by the same date. This need not have spelled disaster, but only if the supply system had been able to adapt to circumstances.

Impressive as the achievements of the Third Army were, they were not without parallel. During the Vistula-Oder operation of January 1945, the 1st Ukrainian Front covered roughly the same distance as Patton, albeit in 3 weeks. Such was the pace of the advance, the Russian transport system was unable to meet the demand for gasoline even though considerable quantities of fuel were captured. Fuel trucks had to make journeys of 300 miles or more, before returning in pairs, one towing the other, to conserve fuel. Some regiments were denuded of all their fuel-carrying trucks, but this could not prevent the Second Guard's Tank Army from having to halt for 5 days, and the Fourth Tank Army for 6 days, for want of fuel.²⁰ By this yardstick, therefore, the American logistics system was no worse than the Soviet Army's, albeit the former possessed significantly more resources.²¹ Perhaps the most telling criticism of the logistics planning for Overlord is that it was largely conducted in isolation from operational considerations. As General Henry Aurand later wrote,

... an analysis of World War Two leads to the inescapable conclusion that those charged with its conduct either lacked knowledge of the logistic art, and the basic principles of organisation; or they chose to disregard one or both."²²

The fateful decision to abandon Operation Chastity (and the plans for Quiberon Bay) is described in the official history as "... the first step in a repeated subordination of logistic considerations to prospects of immediate tactical advantage ...".²³

The result was the Allies were unprepared to take advantage of the opportunity to destroy the German forces before winter. Quite simply, "... there was not sufficient time to make the necessary readjustments in the logistical machinery ...".²⁴

Conclusion

Logistics shortages were clearly the primary reason for Patton's halt on the Meuse in 1944. But given the vast resources available to the Allied armies, they should have been much better placed to exploit the strategic opportunities available after the Normandy breakout. The failure arose from inadequate planning coupled with an inefficient and seriously flawed logistics organisation. No single agency was tasked with the direction and control of the logistics effort for the duration of

the Normandy campaign. Admittedly, the scale and speed of the breakout would have caused severe strain to any organisation, but it need not have proved quite so debilitating. It would seem that the Overlord logisticians never considered flexibility as a military virtue.²⁵

That said, it could also be argued that culmination was inevitable. Logistics shortages were just one element in the growing friction that—in the form of increased vehicle breakdown, limited casualty replacements, and delays in airfield construction—would have curtailed operations in any event. The lack of fuel may even have saved Patton from his own impetuosity. The arrogance and opportunism that had served the Third Army so well in its spectacular breakout could just as easily have broken it on the wheel of an increasingly strong German defence. Carlo d'Este has written that Patton's Achilles' heel was that rather than cut his losses he would attempt to storm his way out of a bad situation.¹ Before the year was out, the Ardennes offensive would show the Allies just how formidable and tenacious an enemy they still faced. Nevertheless, the intriguing possibility remains that properly supported the Third Army's momentum could just have carried it into Germany and secured victory in 1944. If any general could have succeeded in such a venture, it was probably Patton.

Notes

1. D'Este, 634.
5. Waddell, 25.
6. *Ibid.*, p. 46.
7. *Ibid.*, p. 106-7.
8. Carlo d'Este, *A Genius for War*, London: Harper Collins, 1995, 649.
9. Christopher R. Gabel, *The Lorraine Campaign—An Overview*, Fort Leavenworth, Kansas, 1985, 5.
10. For example, the Third Army received 396,000 gallons on 12 August, 367,000 gallons on 19 August, and 285 gallons on 26 August, leaving a balance on hand of just 0.6 days' supply.
11. Waddell, 107.
12. Martin van Creveld, *Supplying War*, Cambridge University Press, 1977, 214.
13. Patton, 119-120.
14. D'Este, 21.
15. Brenton G. Wallace, *Patton and His Third Army*, Harrisburg, Pennsylvania: Military Service Publishing Co., 1946, 88.
16. Bodo Zimmerman, *The Fatal Decisions*, London: Michael Joseph, 1956, 205-209.
17. Patton, 119-120.
18. Ronald G. Ruppenthal, *Logistical Support of the Armies*, Dept of the Army, 1950, 577.
19. *Ibid.*, 582.
20. Christopher Duffy, *Red Storm on the Reich*, London: Routledge, 1991, 347-348.
21. This point is well made by Van Creveld, 212-215, who finds it hard to reconcile the pessimism of the planners with the superabundance at their disposal.
22. Waddell, xvi.
23. Ruppenthal, 483.
24. Forrest Pogue, *The Supreme Command*, Dept of the Army, 1954, 260.
25. Russell E. Weighley, *Eisenhower's Lieutenants*, Bloomington, Illinois: Indiana Univ Press, 1981, 419.
26. D'Este, 634.

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Personnel Information Career



AFAS UPDATE

With the first cycle of AFAS complete, it is safe to say the system works as advertised for the logistics career fields. The first cycle began in October 1998 with assignment teams identifying officers that were vulnerable to move in the summer reporting cycle. The major commands (MAJCOMs) passed the vulnerable movers' list (VML) to the unit commanders, who subsequently notified the affected officers. Unit commanders spent the better part of November reviewing the VML and providing feedback to the assignment teams. Based on input from the field, some additional officers were added to the list while some others were subsequently removed from the list. Once the VML was validated, unit commanders submitted requisitions to fill their projected vacancies.

When requisitions for officers are sent to the Air Force Personnel Center (AFPC), they are reviewed and validated by the assignment teams. These teams review the requisitions with respect to the unit's overall manning and worldwide manning averages to ensure all units receive their fair share of officers. The validated requisitions are visible on the Personnel Requirements Display (PRD) for a 30-day period during the month before AFPC begins matching assignments for that quarterly cycle. The PRD is located within the AFAS web page (www.afpc.randolph.af.mil). For the month of December, officers with Internet access could view vacancies that were projected for the summer reporting cycle.

The preference worksheet (PW) allows officers to communicate their desires through their PW reviewer to the assignment teams at AFPC. The assignment teams use the PW to match qualified officers to requirements. Through the PW, officers identify five duty preferences within certain parameters such as Air Force specialty code (AFSC), duty title, location, tour length, and level of duty. In addition to the top five preferences, the officer can provide more detailed information regarding the preferences. As an example, many officers list some preferences or provide background information on special circumstances that drive their preferences. Since the assignment teams consider these comments in the assignment match process, officers should be realistic when indicating preferences on the PW. For instance, there are a finite number of positions available at the bases in Florida. Therefore, an officer who indicates Eglin AFB in all five available blocks is less likely to be matched to a preference than an officer who lists several duty locations.

Although the PRD provides the basis for completing a PW, it is not the sole resource. During the first assignment cycle, there were several out-of-cycle requisitions that popped up. Many of these were generated when officers were selected for professional military

education or special duty. While officers will generally not be aware of these out-of-cycle requirements, they will still be filled. If the position is a critical fill, the assignment teams post a notice on their home page. Additionally, officers can view the authorizations listing on the AFAS web page. This authorization listing shows all of the positions worldwide that are authorized for a specific AFSC. When completing their PWs, some officers use the authorization listing PW to find other locations that may not have requirements projected on the PRD.

Assignment teams do not have access to the PW until a reviewer completes the comment block and forwards the PW to AFPC. The PW reviewer plays a very important role since the comments are heavily weighed before an assignment is matched. In fact, if a match is not made with the officer's preferences or reviewer's input, the assignment team contacts the PW reviewer to discuss options for the officer.

The assignment match process represents the largest improvement AFAS has brought to the assignment business. Rather than being limited to selecting an officer from a list of volunteers, positions are now filled from the list of officers identified on the VML. The larger pool of available officers helps ensure the right officer is placed in the right position based on Air Force needs, officer professional development, and officer desires.

During the first cycle of AFAS, the largest limiting factor to completing successful matches was the size of the VML. There were 442 requisitions submitted in-cycle for summer fills, but only 350 of those were actually filled. With the manpower shortages the logistics community is experiencing, it is reasonable to assume that the assignment teams will be unable to fill some positions during every assignment cycle. To ensure the right positions are filled, the assignment teams work with the MAJCOMs and hiring authorities to prioritize projected vacancies and guarantee that officers are sent to the units that need them most.

Once an officer is matched to a position, the assignment team sends an e-mail notification of the pending assignment to the gaining commander, officer PW reviewer, and the MAJCOMs. All parties have the opportunity to review the proposed assignment and provide feedback. If either the gaining or losing unit does not concur with the assignment, a reclama can be submitted through the group commander (or equivalent). During the first cycle of AFAS, the logistics officer assignment teams successfully matched officers to assignments that met the approval of their PW reviewers 97 percent of the time.

(Capt David B. Belz, AFPC, DSN 665-3556)

back orders at any point in time. However, this definition is not always clear or useful, but there are other equivalent interpretations, such as BOs existing each day per day, BO days per day, or days back ordered per day.

A More Useful Form

To obtain a more useful form for EBO, start by counting the number of back orders per day and then rearrange the terms:

$$EBO = \frac{0+2+2+2+2+3+2+2+1+1}{10} = \frac{0+1+1+2+2+2+2+2+2+3}{10} \\ = \frac{0*1+1*2+2*6+3*1}{10}$$

In this last equation, 0 occurred one time, 1 occurred two times, 2 occurred six times, and 3 occurred once. If each of the terms in the numerator is divided by the 10 in the denominator, the result is:

$$EBO = \frac{0*1}{10} + \frac{1*2}{10} + \frac{2*6}{10} + \frac{3*1}{10} = 0*\left(\frac{1}{10}\right) + 1*\left(\frac{2}{10}\right) + 2*\left(\frac{6}{10}\right) + 3*\left(\frac{1}{10}\right)$$

What are the numbers in parentheses? Probabilities. Consider the BOs in existence each day: 0, 2, 2, 2, 2, 3, 2, 2, 1, 1. 0 occurs one out of ten times, 1 occurs two out of ten times, 2 occurs six out of ten times, and 3 occurs one out of ten times. So the probability of getting a 0 based on this sample is 1/10 and so on. Now going back to the EBO computation, one sees: $EBO = 0*\text{Prob of } 0 + 1*\text{Prob of } 1 + 2*\text{Prob of } 2 + 3*\text{Prob of } 3$. Noting from the sample that the probability of getting a 4 is 0/10, then the probability of getting a 5 is 0/10, etc. EBOs can now be written as:

$$EBO = \sum_{i=1}^{\infty} i * (\text{Probability of } i \text{ backorders})$$

Mathematical Foundation

At the center of the RBL model is the Multi-Echelon Technique for Recoverable Item Control algorithm. This method was first developed by Sherbrooke in the 1960s, but it is still applicable today.⁴ A short synopsis of the mathematical foundation of the method follows.

Probability Functions

The demand pattern, length of the repair cycle, and so on are not constant values but vary (sometimes tremendously) over time. However, theory has shown they follow patterns that can be relatively accurately modeled using standard probability functions. In this case, RBL uses the negative binomial probability.

$$P(x) = P(x; \mu) = \frac{(k+x-1)!}{(k-1)! x!} \left(\frac{q-1}{q} \right) \left(\frac{1}{q} \right) \\ x = 0, 1, 2, \dots \\ q > 1 \quad \text{is the variance - to - mean ratio} \\ k = \frac{\mu}{q-1} > 0$$

This is interpreted as the probability of exactly x demands given mean m where m is the average number of demands during a repair cycle (base and depot repair, order and shipping time, and so forth.). So to use this probability function, two parameters are needed: mean, m , and the variance to mean ratio, q . In RBL, q is obtained through an empirical formula instead of using the data.⁵ There are both base and depot means to consider. The formulas used in RBL for these are:

$$\text{Depot Mean} = \text{Depot DDR} * \text{Depot RCT}$$

$$\text{Base Mean} = \text{RTS} + \text{NRTS} = [\text{Base DDR} * \text{PBR} * \text{Base RCT}] + [\text{Base DDR} * (1 - \text{PBR}) * (\text{OST} + \text{NCT} + \text{ADDD})]$$

Where:

RTS = Repaired This Station

NRTS = Not Repaired This Station

DDR = Daily Demand Rate

RCT = Repair Cycle Time

PBR = Percent Base Repair

OST = Order and Ship Time

NCT = NRTS/Condemned Time

ADDD = Average Depot Delay Per Demand

Look at each of these means. The depot mean takes the depot daily demands (sum of based NRTS demands) times the average number of days to repair in the repair cycle to give the number of demands during an average depot repair cycle. The base mean involves a similar computation; however, it just splits the demands between those repaired locally (RTS) and those sent to the depot for repair (NRTS).

Expected Back Orders

Unlike the conceptual example, in RBL, there is no sample of back orders to compute the probabilities. As a result, an assumption must be made as to the distribution. As can be guessed, the assumption is made that demands are distributed based on the negative binomial just discussed. In addition, it must also be realized that in RBL the number of back orders is going to be dependent on the number of levels allocated to satisfying demands and the pipeline. With this in mind,

$$O(s) = \sum_{i=1}^{\infty} i * (\text{Probability of } i \text{ backorders given } s \text{ levels})$$

given s levels. Remember that $P(x)$ is the probability of x is the general representation of the expected back orders demands and that a level can be thought of as a unit on hand or due in during the repair cycle period. With s levels and x demands, then $x-s$ is the number of demands for which there is no asset, therefore a back order. If $i=x-s$ and is substituted into the above equation:

$$EBO(s) = \sum_{i=1}^{\infty} i * (\text{Probability of } i \text{ backorders given } s \text{ levels})$$

Expanding this equation for $s-1$ levels and s levels respectively:

$$\begin{aligned} \text{EBO}(s-1) &= 1 \cdot P(s) + 2 \cdot P(s+1) + 3 \cdot P(s+2) + \dots \\ \text{EBO}(s) &= 1 \cdot P(s+1) + 2 \cdot P(s+2) + 3 \cdot P(s+3) + \dots \end{aligned}$$

Subtracting results in:

$$\begin{aligned} \text{EBO}(s-1) - \text{EBO}(s) &= 1 \cdot P(s) + (2-1) \cdot P(s+1) + (3-2) \cdot P(s+2) + \dots \\ &= P(s) + P(s+1) + P(s+2) + \dots \\ &= \sum_{x=s}^{\infty} P(x) = \sum_{x=0}^{\infty} P(x) - \sum_{x=0}^{s-1} P(x) \\ &= 1 - \sum_{x=0}^{s-1} P(x) \end{aligned}$$

But the last sum is just the cumulative probability function at $s-1$. Since this is a positive value less than 1, the change in expected back orders by adding the *next* level is positive. That is, when a level is added, the expected back orders decrease by 1—cumulative probability ($s-1$).

What are the EBOs if no levels are given? The EBOs will equal the mean (depot or base as appropriate). Why? If there are no levels, then each demand will cause a back order. Since there are no levels to account for parts in the repair cycle, it cannot be assumed that there are any parts in the pipeline due into the base. So it will take the entire repair cycle for the back order to be satisfied. Or the number of back order days per demand will equal the repair cycle period. That multiplied by the number of demands per day (DDR) equals the number of back order days per day. But that is just EBOs. Therefore, $\text{EBO}(0) = \text{DDR} \cdot (\text{Repair Cycle Period}) = \text{Mean}$.

Depot Impacts

In the previous example, the levels allocated and the probability function determine EBOs. Earlier, it was seen that the probability function used the base mean (m), but how does the depot mean and depot levels come into play? In the base mean formula, the term ADDD (average depot delay per demand) appears. It is in this term that the depot levels, demands, and delays are accounted for.

$$\text{Average Depot Delay Per Demand} = (\text{Average Depot Delay Per Day}) / (\text{Average Demand Per Day})$$

But, Depot Delay is just another way of saying Depot Back Order Days. So:

$$\text{ADDD} = (\text{Average Depot Back order Days Per Day}) / (\text{Average Demand Per Day})$$

Earlier it was shown that back order days per day is the definition of EBOs. Also, average demands per day is the definition of DDR, so:

$$\text{ADDD} = (\text{Depot EBOs}) / (\text{Depot DDR})$$

To compute the depot EBO, exactly the same approach is used; however, the depot mean and depot levels are used instead of base means and levels. The longer the average depot delay per demand, the longer it takes to return an asset to the base, which increases base back orders. RBL measures the effect on the base EBOs of the level allocated to the depot.

RBL Allocation

Detailed Algorithm

Increasing the levels changes EBOs, but how does the system choose which base to give a level to? RBL uses what is often referred to as a marginal analysis approach. The basic allocation rules are as follows:

1. Obtain the input variables (DDR, RCT, OST, NCT, PBR) for all bases and depot for one subgroup master (SGM) national stock number (NSN). If more than one SGM is present for the family, read all the SGM NSNs for the family. Sum the base DDR and weight average the other quantities. This gives the input variables at the family master level—where RBL computes levels.
2. Set the depot level to 0. From that and the input variables, depot EBOs can be computed, but more important, the ADDD can be computed.
3. Set all base levels to 0. From that, ADDD, and the input variables, the base mean and $\text{EBO}(0)$ can be computed for each base.
4. Using the change in EBO formulas given earlier, compute the reduction in EBOs for all bases going from 0 to 1 level [$\text{EBO}(0) - \text{EBO}(1)$]. The base that has the biggest reduction in EBOs is selected to receive the level. Only one level is allocated, and all other bases do not receive a level (yet).
5. Repeat the previous step determining the reduction in EBOs for all bases getting their next level. For one base, that will be going from 1 to 2 levels; the others will be going from 0 to 1 level. Once again, the one with the largest decrease in EBOs is selected.
6. Keep allocating levels to the bases one at a time until the number of levels allocated to the depot and bases equals the requirement, then stop.
7. Sum the base EBOs to obtain the system EBOs. That is the best allocation given 0 depot levels.
8. Now, try a depot level of 1 and repeat steps two through seven. If the resulting system EBOs are less than the previous allocation, keep the new allocation. Otherwise, keep the allocation with 0 depot levels.
9. Keep trying to increase depot levels until the entire requirement is given to the depot. For each depot allocation, an optimal base allocation is obtained and system EBOs compared in order to keep the smallest one.
10. When done, there is an allocation to the depot and bases with the smallest system EBOs. This is reported, and the whole process is repeated for the next NSN.

Example. In order to further understand the allocation process, an NSN has a requirement of five and three stock record account numbers (SRANs) (A, B, and C). The results of each pass through the algorithm are shown in Table 2.

In this example, there are six passes, one each for the depot levels 0 to 5. The detailed middle steps are eliminated, and just the results at the end of each pass are shown. In all six passes, the entire requirement of five was allocated, some to the depot and some to SRANs. Looking at the system EBOs, the smallest value is for the third pass.⁶ So that is the allocation that will be used.

	1st pass		2d pass		3d pass		4th pass		5th pass		6th pass	
	Level	EBO	Level	EBO	Level	EBO	Level	EBO	Level	EBO	Level	EBO
Depot	0		1		2		3		4		5	
SRAN												
A	2	0.90	2	0.70	1	0.80	1	0.75	1	0.70	0	1.20
B	2	0.80	1	0.70	1	0.65	1	0.60	0	1.00	0	0.90
C	1	0.50	1	0.40	1	0.30	0	0.80	0	0.70	0	0.60
System EBOs		2.20		1.80		1.75		2.15		2.40		2.70

Table 2. RBL Allocation Sample

There are, however, some interesting outcomes seen in Table 2. For example, looking at SRAN B going from the first to second passes, the base levels decreased, but so did the EBOs. How can that happen? Because of the multi-echelon nature of RBL, this is frequently the case. The depot level increased, which would cause the depot delay to decrease (ADDD decreases). Since ADDD is used in the base mean, the base mean would also decrease. A different base mean results in a slightly different probability function (remember the mean is used in the probability function) and different EBO value. Outside of the mathematics, if the SRAN sends most of its parts to the depot, having a larger depot level will help the base. At the same time, having fewer levels at the base hurts the base. It is a matter of one helping the base more than the other hurting the base (in terms of EBOs). Later on for SRAN B going from the fourth to fifth pass, the depot receives another level, and SRAN B receives one less, but this time EBOs increase since there are diminishing returns. Adding more levels to the depot will always help, but the amount it helps becomes less and less.

You can probably see now why RBL is often viewed as a black box. With several input variables, many SRANs (both organizational intermediate maintenance and depot level maintenance), two echelons (base and depot), uncertainty (probability functions), predicted results (EBOs), and so forth, it is a very complicated process. However, the *real* Air Force supply system is often an even more complicated, intertwined, and uncertain system. Compared to the RCDL, RBL makes great strides in taking many of these factors into account.

Other Issues

We have talked about expected back orders several times here, but the everyday Air Force talks in terms of back orders and not expected back orders. What is the relationship between the two?

Back Orders Versus Expected Back Orders

Many people want to examine BOs and not EBOs. This is because the data on BOs (mission capabilities, due-outs, and so forth) is collected. BOs are event-driven transactions that occurred in the past, whereas EBOs are statistically predicted future averages.

From the conceptual example given in Table 1, there were three BOs. A common mistake is to think the RBL EBO number is the number of back orders or the number of back orders divided by number of days. Neither is true. BO/day would be interpreted as the average number of new back order *occurrences* per day, which is different from the EBO definition. We can also see in the example that $4/10 = 0.4$ is not the same as 1.7 given earlier as the EBO.

Can one be converted to the other? Yes and no. In this simple example, yes. In RBL, it is not as easy. In the conceptual example, take EBOs, multiply by the number of days and divide by the average length of a back order to get number of BOs. In the

example, the BOs lasted 5, 7, 3, and 2 days, so the average length was 4.25 days. Therefore, number of BOs = $EBO * (10 \text{ days}) / (4.25 \text{ days per BO}) = 1.7 * 10 / 4.25 = 4$ BOs. That was simple enough. But what about RBL? In RBL, the average length of a back order is not known. Approximations have been attempted using various methods that included fixed numbers, average order and ship period, and the average repair cycle period. It is hard to verify these approximations because of many other factors. Therefore, this is not done.

Are EBOs Good Numbers?

Yes. Minimizing EBOs means that either the number of BOs is minimized, or the length of the BO is minimized, or both. Eliminating BOs, or at least reducing the number of them, is a primary goal. However, that cannot always be done, but the user can still be helped by reducing the time waiting for the part. So reducing the number or length of BOs is a good goal, and using EBOs allows both to be minimized.

What are some of the *other factors* that keep EBOs from RBL (even after conversion/approximation to BOs) from being closer to *real world* BOs?

1. **Back Order Length.** The average length of a back order is not completely known, so there are inaccuracies in the conversion from EBOs to BOs.
2. **Time Frames.** BOs are discrete events from the past given such things as existing levels, assets, and funding. RBL uses past data to predict future data and determine the optimal levels, which may be different than currently exist. So EBOs are forward-looking predicted values that are based on several assumptions.
3. **Changing Demand Pattern.** A major assumption in RBL is that past demands are good predictors of future demands (also true of RCDL, economic order quantity, and almost any supply system). If this assumption does not hold for some part, then EBOs were computed on the wrong values. Of course, this would not be known until after the fact.
4. **RBL ignores some of the *real world*.** For example, it does not consider parts in a Readiness Spares Package (RSP) in determining levels, yet a base with an RSP will use those parts to avoid BOs. Similarly, RBL does not consider High-priority Mission Support Kit parts, cannibalization, and lateral support. These are not mistakes but deliberate choices by the supply community to not consider those parts and concepts when leveling.
5. **Assets.** Readiness-based Leveling deals with levels, not assets. It assumes that assets are available (or will be made available) if levels are available. In general this is true, but for a few thousand parts it is not true.
6. **Funding and Priorities.** RBL has to assume that a part will get fixed based on a repair pipeline. In reality, some parts are never fixed because of funding and priorities or get fixed and sent to places other than the base that is next in the queue based on priorities.
7. **Bottom Line.** The RBL EBO number is good based on what it is asked to do. RBL is given some reasonable assumptions and told to ignore certain things and then come up with base and depot levels that should provide the best overall support.

Special RBL Rules

So RBL does a reasonable job with what it is asked to do; but it has the tasking to do everything for everybody. So there have to be some exceptions and other special rules for different subsets of the parts. Although these special rules can confuse matters a bit, having all recoverable parts run through RBL, even if they use a special rule, puts all the rules in one place. Otherwise, there could be many different leveling systems in many places—not a good choice. Some of the special rules in RBL follow.

1. **Adjusted Stock Levels (ASLs).** ASLs are honored in RBL as they are part of the worldwide requirement. Since a base with an ASL may or may not have demands, the regular algorithm will not work for them. Given the worldwide requirement is sufficient, ASLs are essentially allocated first, regardless of the savings in EBOs at any other base. The ASL was (theoretically) approved and included in the requirement, so RBL should allocate the requirement to the ASL. For each level allocated for an ASL, the EBOs for that base are reduced just as they were before. However, if the base had no demands, the EBO would be zero for that base, and there would be nothing to reduce. Once all the levels to support ASLS are allocated, the algorithm continues as before allocating to the user that reduces EBOs the most. If the ASL is a fixed type, that base is eliminated from consideration for any more levels once the fixed ASL is met. Similarly, if a maximum ASL is present, once the maximum is reached (including a Max 0), that base is no longer considered for a level.
2. **Initial Spares Support Lists (ISSLs).** For the most part, ISSLs are allocated like any other minimum ASL. However, there are some NSNs where the requirement is insufficient to meet all the needs. In those cases, ISSLs are given a lower filling priority. That is, regular ASLs and demand pipelines will be filled before ISSLs are considered.
3. **Contingency Spares Support Levels (CSSLs).** CSSLs are levels in support of a Contingency High-Priority Mission Support Kit (CHPMSK). CHPMSKs use peacetime stocks in support of contingency operations. CSSLs are added to regular ASLs and then allocated in RBL like ASLs. However, RBL levels pushed to the base have the CSSLs deleted so as not to double count them in the requisition objective at the base, since CPHMSK increases the requisitioning objective (by the CSSL amount).
4. **Smaller Depot Level Cap.** When considering one pass with a given depot level and the next pass, the one with the smaller system EBO is kept. But what happens if the two allocations have virtually the same system EBOs? Instead of sticking strictly to the algorithm, if the difference in system EBOs is *less than a very small number*, it is considered that they both have the same EBOs. In those cases, the allocation with fewer depot levels and more base levels is used.
5. **Requirement Cap.** The system keeps allocating until all the requirement is given, but there are diminishing returns in giving levels to either the depot or base. So if giving the next level to the best base (the one that reduces EBOs by the most) only changes system EBOs by a trivial amount, the allocation is stopped. Giving levels after this point would fill the system with unnecessary requisitions that probably would not be needed for years (encourages fixing *buggy whips*).
6. **Pipeline Cap.** In order to ensure outliers in the input variable do not overly sway the allocation, RBL caps certain variables. Base repair cycle time (RCT) is capped at 10 days. Depot RCT is capped at 210 days. CONUS Order and Ship Time (OST) is capped at 24 days, while OCONUS OST is capped at 52 days. NRTS/Condemned Time is capped at 3 days.
7. **Insurance and Nonconsumable Item Materiel Support Code (NIMSC5) NSNs.** Insurance NSNs are checked for demand usage. If two or more demands are found, the cataloging is considered suspect, and base levels are allowed. Otherwise, by policy, base levels are not allowed on insurance NSNs. Similarly, NIMSC5 NSNs are parts where the Air Force is the Single Inventory Control Activity. These parts are not allowed to have depot levels as the depot repairing the part is from another Service.
8. **Communications-Electronics Rule.** Budget program 8M parts tend to be expensive and seldom used parts. Based on Air Force Logistics Management Agency (AFLMA) studies and work at the Air Force Communications Agency, special rules were developed to handle these parts. Basically, the rules will fill ASLs first, then try and put at least two levels at the depot, then finally allocate anything remaining to bases with demands (for non-Numeric Stockage Objective parts). The main differences are the depot levels and lack of demand-based levels. The two levels at the depot are to provide a central stocking type concept on most of these parts instead of a distributed stocking concept. The lower priority for demand-based users is because of the very low demands and reliability of the parts. Past demands at one location are not necessarily a good predictor of future demands at that location. ASLs are used in locations where the assets are really needed, single-point failures, and the lack of an asset would make an essential communications system inoperable.
9. **AMC Forward-Supply Locations (FSLs).** FSLs are supply locations that handle the en route needs of the strategic airlift system. At the time this article was written, Headquarters Air Materiel Command computed the levels, and these were loaded as fixed ASLs at the FSLs. RBL then allocates these off the top like any other fixed ASL. However, a project is underway to have RBL do the computation for the FSLs. This would be a separate algorithm within RBL that takes a system approach to demands in determining the allocation.⁷
10. **Depot Working Level.** Once the best overall allocation is determined, the depot level needs to be split into components: consolidated reparable inventory (CRI), work in progress (WIP), and consolidated serviceable inventory (CSI). CSI will be the levels above the depot mean (if there are any). CRI and WIP will prorate the level (up to the depot mean) based on the retrograde portion of depot RCT and repair portion of depot RCT respectively. These pieces of depot RCT are input variables to the model. Once the depot level is split, WIP and CSI are added to form the depot working level. This number is output for use in the Execution and Prioritization of Repair Support System for depot repairs.
11. **Miscellaneous.** There are several other minor rules in RBL, such as ignoring Federal Stock Code 1300 and 1399 items and non-FB SRANs. These are all very special cases and only affect a few parts and users.
12. **Problem Item Heuristic.** The last special rule is for problem items. When the requirement is less than the heuristic pipe (demand pipeline plus ASLs), the NSN is flagged. Something must be wrong with the requirement, data, policies, and so forth for this to occur. The question here is how should RBL allocate these levels? As noted earlier, ASLs are allocated first. This implies some bases would receive less than their mean demand pipelines (for each part put into the pipeline, less than one part comes back out). This unduly harms demand users, the ones who have an established history of use, at the expense of ASLs. The problem item heuristic is a *deepest hole* type of algorithm that resolves this problem. In these cases, the RBL model is run above ignoring all ASLs. The resulting allocation is used as targets for the deepest hole. To these targets, ASLs are added. The heuristic then allocates levels one at a time based

on the largest hole determined by (levels allocated)/(target). This rule provides a more equitable distribution of the shortage between demand users and ASL users. The NSNs are flagged and passed on to AFMC item managers for resolution.

Conclusions

The Air Force supply system has many constraints: resources, manning, funding, and facilities. By performing a *constrained optimization*, RBL provides the best allocation of those limited resources. It reduces back orders and provides a more complete picture of a base's need than RCDL, and it ties the base levels to the funded requirement.

Notes

1. Craig S. Sherbrooke, *Optimal Inventory Modeling of Systems: Multi-Echelon Techniques*, New York: John Wiley & Sons, 1992, 23.

2. Steven B. Reynolds, Mark A. Abramson, Douglas K. Blazer, Karl Kruse, and Wayne B. Faulkner, *Setting Recoverable Item Stock Levels*. AFLMA Report LS199500500, December 1995, 3.
3. Henry Triwush, *D028 Training Document*. HQ AFLC, Wright-Patterson AFB, Ohio, November 1978, 40.
4. Sherbrooke, 45.
5. J. J. Bartko, "Approximating the Negative Binomial," *Technometrics*, Vol 8, No 2, 1966.
6. Sherbrooke, 75.
7. James Neice, David A. Fulk, Bradley Silver, Douglas J. Blazer, and Harry A. Berry, *Forward Supply System—Forward Supply Locations (FSL) Data and Requirements Pass*. AFLMA Final Report LS9710500, September 1997.

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(A Global Infrastructure to Support EAF continued from page 7)

reduction in recurring costs comes from the reduced airlift needed to transport SBSs for exercises.¹⁸

Conclusions and Challenges

In looking at the current force structure and its current support processes, our analysis leads to several conclusions:

To get close to the execution order plus 48-hour deadline for placing the first bombs on target, AEWs must deploy to category-1 bases. Further, given that a flight halfway around the world takes approximately 20 hours, pushing the timeline below 48 hours will require either having people deployed or materiel at an advanced state of preparation at the FOL or both.

Equipping numerous category-1 FOLs from scratch would be very expensive. Although much of the cost for current processes might well be sunk, maintenance and storage costs will still have to be paid. Anecdotal accounts of current (nonurgent) deployments to Southwest Asia indicate current maintenance arrangements there do not keep equipment ready for immediate use, suggesting that these costs might be larger than are paid now. Further, future munitions and improved support equipment not already in the inventory would have to be bought for the FOLs. Therefore, significant attention should be given to resourcing a number of FOLs in each category in order to provide a range of employment timelines for operational use. Within different regions, different employment timelines may be required. Not all regions may need to have category-1 FOLs or necessarily the same number of category-1 FOLs. The identification of various categories of FOLs throughout the world is important for supporting not only AEF operations but also major theater war operations. Attention should be given to pursuing host nation support agreements to the extent possible to offset costs and lift requirements.

FSLs provide a compromise in cost between prepositioning at FOLs and deploying everything from CONUS.¹⁹ They have little effect on the timeline for initial capability, but they do avoid the necessity of having a tanker air bridge for the extra strategic lift from CONUS. Further, the strategic lift then becomes available for use in deploying additional combat units.

Category-2 bases represent another compromise between cost and timeline. However, deploying to a category-2 base takes about 3.3 days (airlift flow and unloading airlift aircraft) and 2-3 days to set up munitions and fuels storage. Increased ramp space would not significantly speed up the deployment process. Plus, the agreements for vehicles, medical facilities, and so forth would probably require some time to finalize

unless very complete arrangements had been completed well in advance.

Category-3 bases are not useful as FOLs for very quick crisis response given the time required for airlift offload operations and to set up the support processes. However, this is a function of the current processes, and the timeline estimated here is for a stressing combat scenario. A less stressing combat scenario or a humanitarian operation might well be feasible from such a category-3 FOL within the 48-hour timeline.

The concept of the Expeditionary Air Force has significant implications for two Air Force core competencies: Agile Combat Support and Global Mobility. Rapid deployment places an emphasis on reducing the logistics support that must be deployed, but the current force structure and current logistics processes mandate a forward logistics structure that prepositions equipment and support packages in order to meet potential operating tempos. FSLs, logistics C2, and very responsive resupply can also reduce the amount of materiel and people that need to be deployed to FOLs. New technologies and continuous process refinement can also reduce the deployment footprint over a period of years.

The deployment footprint could be reduced in three major areas: munitions, ground equipment, and shelters. Continued research is needed to reduce the weight and bulkiness of munitions and support equipment.²⁰ The weight and volume of the current bare-base shelter package could be eliminated via commercial alternatives, some of which are being explored by the Airbase Systems Command at Eglin AFB.

The issues concerning FOLs, FSLs, and their location and equipping require some planning decisions be made centrally from a global and strategic perspective. Those decisions should be revisited on a regular basis as the global political situation changes and as technology offers new options.²¹

Our research argues for three major policy changes. First, storage and maintenance policies for prepositioned equipment should be carefully formulated and rigorously enforced, especially if third-party contractors are used to do some or all of the work. Second, host nation support should be considered in planning and execution. How much support can the Air Force expect from allies and how does this change US support requirements? Finally, the other Services could use support concepts similar to the FSL/FOL mixes described here. Indeed, they have already raised similar ideas, and it may prove advantageous to share locations and some resources with them.

Notes

1. See, for example, Paul Richter, "The Tough Job of Keeping Soldiers Ready for War," *Los Angeles Times*, 22 November 1998, and "Buildup in Gulf Costly: Expenses, Stress Surge for Military," *Los Angeles Times*, 17 November 1998. Richter (17 and 22 November 1998) and Matthew Williams, "Plea for Help (from the Air Force Secretary and the Chief of Staff): Better Pay, Bigger Budgets Called Key to Fixing Readiness Woes," *Air Force Times*, 28 September 1998. However, some research has shown that some deployments may improve retention (James R. Hosek and Mark Totten, *Does Perstempo Hurt Reenlistment?: The Effect of Long or Hostile Perstempo on Reenlistment*, MR-990-OSD, RAND, Santa Monica, California, 1998.)
2. As this concept has evolved, some of the details have been modified. At this writing, the structure consists of ten AEFs as described, two units for pop-up contingencies, and five AEFs for humanitarian/evacuation operations.
3. There is no general term for the force package actually deployed, although AES (for squadrons), AEW (for wings), and AEG (for groups) have been used. In this paper, we call the actual deployed force of whatever composition an AEW.
4. Footprint is the name given to the size of the materiel needed to deploy a specific force. If airlifted, the footprint is expressed in airlift equivalents (for example, 12 C-141 loads); if stored, in terms of warehouse space.
5. Planners at USAF have independently developed a similar classification for bases in their theater. HQ USAF/ILM has also proposed a division of bases for their planning analyses.
6. These data are from the 4th Fighter Wing's deployment to Qatar, but other deployments have similar patterns. This deployment was not done on short notice, and there was little reengineering of support processes although UTCs were extensively examined and tailored. However, our models capture individual processes in sufficient detail to permit evaluation of process modification and tailoring.
7. More details may be found in Robert S. Tripp, Lionel Galway, Paul S. Killingsworth, Eric Peltz, Timothy L. Ramey, and John Drew, *Integrated Strategic Support Planning for the Expeditionary Aerospace Force*. RAND MR-1056-AF, Santa Monica, California, January 1999.
8. RAND is examining several issues germane to risk and flexibility (Wendt, 1998, unpublished research).
9. In our munitions modeling, we accounted for all munitions that would be used in support of this AEF force package including air-to-air munitions, HARM missiles, chaff/flares, and 20mm gun ammunition.

10. We have assumed that US forces must set up temporary fuel storage on a prepared site so that fuel for US aircraft can have additives added independently of host base fuel.
11. This does not take into account the much more demanding air bridge (tankers, etc.) that must be in place to use airlift from CSLs.
12. Setup requires 4.6 days with a dedicated 150-person crew in a temperate climate.
13. There are two omissions from the investment cost. First, we defer considering the cost of building FSLs or constructing new FOLs in a theater of interest because these installations may be provided by an ally's bases or by adapting existing facilities. Second, we present the total purchase price without considering the fact that some of the equipment and consumable costs could be sunk.
14. The aviation maintenance equipment is assumed to be brought with the unit.
15. Each FSL has two sets of equipment, but if there is reachback to the CONUS, the CONUS only needs two sets total.
16. In this analysis, we assumed that each F-15E carried six SBSs.
17. The SBS is only under test and has not been procured. The costs shown here are, therefore, money that must be programmed and expended, unlike the costs for the GBU-10, which are largely sunk.
18. Note that we have assumed that rapid transportation is available for movement of munitions to an FOL when they are stored in an FSL or in the CONUS.
19. Much of the difference in recurring costs occurs because of the expense of running exercises from CONUS and the form of the exercises.
20. The AEF Battlelab at Mountain Home AFB is overseeing development of a combined compressor/air-conditioner for flight-line use, and the Aerospace Ground Equipment Working Group is investigating items such as collapsible maintenance stands. The Air Force Research Laboratory at Wright-Patterson AFB is investigating modular support systems for both legacy and future weapons systems.
21. For a more complete description of an enhanced planning process for global support infrastructure see Tripp et al., 1999.

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(The Technologically Hollow Force of the 21st Century continued from page 9)

type from 1995 showed 65 percent of all RC-135 flight hours devoted to peace operations.²⁰ Similarly, 60 percent of all 1995 flight hours for the E-3 were devoted to peace operations. By contrast, the percentage of total USAF fighter flight hours devoted to peace operations was 12 percent for the A-10, 10 percent for the F-15 and F-15E and just 7 percent for the F-16.²¹ Foreign deployments to Bosnia and Iraq in fiscal year 1998 cost \$3.5B with about \$2B being spent in Bosnia operations and about \$1.5B being spent on no-fly zone operations in Iraq.²²

Units deploying in support of unplanned contingencies do not have extra funds for these efforts. Every year the Services submit a request for supplemental appropriations to cover the cost of unbudgeted expenses, such as peacekeeping efforts, humanitarian efforts, and MOOTW such as Bosnian no-fly zone operations. When supplemental appropriations are not funded, the Services must pay for it out of hide. "In Fiscal Year 1996, the Air Force spent \$779M on snap operations and got back \$712M, a \$67M shortfall. In Fiscal Year 1997, the Service spent \$852M and received \$827M, a \$25M gap."²³ "... the money comes right out of readiness and modernization unless we get a supplemental appropriation."²⁴ Every year, major acquisition programs are hit with taxes to pay for unbudgeted expenses of operations like Bosnia and Iraq. These taxes wreak havoc on an acquisition program. As an acquisition program's funds are cut, the

program manager must stretch out the schedule or reduce the effort by canceling planned effort. These changes all increase cost and risk of the acquisition program, which often results in increased criticism of the program. Dr. Kaminski's number one priority, prior to leaving office as the Under Secretary of Defense for Acquisition and Technology in 1997, was to get a program stability fund instituted in the DoD to cover unexpected cost increases. Unfortunately, taxes are not cost increases to the program; they are budget consumers and must be stopped.

Conclusions

The technologically hollow force of the 21st century will result from a decade or more of shrinking modernization budgets, an overfascination with technical demonstrators and classified programs and the overwhelming costs of ongoing military operations. The DoD modernization budget has been cut 60 percent over the last decade, but the force structure has only been cut about one-third. This modernization budget reduction, coupled with the common practice of funding current unbudgeted operations costs out of the modernization account, has had a devastating impact on force modernization plans. What little money is available for modernization and R&D is increasingly being spent on demonstrators and classified

programs that offer lots of *gee-whiz*, but little strategic combat power or sustainability. *Joint Vision 2010* says:

In sum, by 2010 we should be able to enhance the capabilities of our forces through technology . . . Enhanced command and control and much improved intelligence, along with other new technology will transform the traditional functions of maneuver, strike, protection and logistics. These transformations will be so powerful that they become, in effect, new operational concepts: Dominant Maneuver; Precision Engagement; Full Dimension Protection; and Focused Logistics.²⁵

As one distinguished lecturer on the 1998 AWC stage said, “. . . these promises are nothing but *bumper stickers*.”²⁶

Notes

1. *Joint Vision 2010*, Joint Chiefs of Staff, Department of Defense, Pentagon, Washington DC, 1998, 1.
2. AF Strategic Plan, USAF AWC 1999 DFC Reader, 285.
3. *Joint Vision 2010*, 18.
4. *Global Engagement: A Vision for the 21st Century Air Force*, Department of the Air Force, Washington DC, 1998.
5. *Joint Vision 2010*, 13.
6. *Ibid.*, 32.
7. *Ibid.*
8. William Perry, “U.S. Military Acquisition Policy,” *Comparative Strategy*, Vol. 13, 1994, 20.
9. *Ibid.*, 21.
10. James P. Stevenson, “The Long Battle for the F-22,” *Aerospace America*, American Institute of Aeronautics and Astronautics, Inc., Reston, Virginia, November 1998, 39.

11. *Ibid.*, 41.
12. Dan Coats, “Joint Experimentation: Unlocking the Promise of the Future,” *Joint Force Quarterly*, Autumn/Winter 1997-98, 14.
13. AWC nonattribution policy prohibits identification of this speaker.
14. Elaine M. Grossman, “Duel of Doctrines,” *AIR FORCE Magazine*, Air Force Association, Arlington, Virginia, December 1998, Vol. 61, No. 12, 33.
15. Jim Cunningham, “Cracks in the Black Dike,” *Airpower Journal*, Vol. V, No. 3, 20.
16. Stevenson, 39.
17. William P. Hallin, “The Challenge of Sustaining Older Aircraft,” *Air Force Journal of Logistics*, Vol. XXII, No. 2, Summer 1998, 1.
18. Alan Vick, et al., “Preparing the U.S. Air Force for Military Operations Other Than War,” RAND, [Online], Available: <http://www.rand.org/publications/MR/MR842>, 1997).
19. *Ibid.*, 2.
20. Alan Vick, et al., “Preparing the U.S. Air Force for Military Operations Other Than War,” RAND, [Online], Available: http://www.rand.org/publications/MR/MR842/MR842.pdf/MR842_chap3.pdf, 1997, 17-23), 23.
21. *Ibid.*, 23.
22. AWC nonattribution policy prohibits identification of this speaker.
23. Peter Grier, “Readiness on the Line,” *AIR FORCE Magazine*, Air Force Association, Arlington, Virginia, December 1998, Vol. 61, No. 12, 40.
24. AWC nonattribution policy prohibits identification of this speaker.
25. *Joint Vision 2010*, 18-19.
26. AWC nonattribution policy prohibits identification of this speaker.

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(Where Is the Battle Line for Supply Contractors? continued from page 13)

Conclusions

The only way success will be identified in future logistical operations is through the maximizing of all assets available to the need at hand. The Army logisticians must embrace all innovations that will maximize the efficiency of the logistical pipeline. The digitization of the battlefield demands the logistics system mature accordingly. Looking to the private sector for better ways to accomplish integration of this digitization is not a bad approach. In fact, using the private sector is an approach that must be taken aggressively but must at all times be tempered with the realization that the Army's primary mission is to fight and win America's wars. Contractors are not trained in combat, and consideration must be given to this fact as items are outsourced through the system.

Contractor support has always played a role on the battlefield and will do so in the future. The concern is finding the right mix of contractor involvement and force structure to support the logistical system. In the case of supply distribution, determination of where on the battlefield the vendor-to-user delivery must stop is critical. With total asset visibility and velocity management initiatives moving forward successfully, the need for this determination is perhaps being ignored.

“Support is a command authority.”²⁴ As such, the integration of nonmilitary sources into the system must be approached cautiously. The supported commander retains the priority of support and is the focus of attention to the Theater Distribution Center when sending supplies into the battlefield. If direct vendor activity is allowed to continue on the battlefield, the TMC, a key to maintaining control of the logistics of the theater, will be bypassed, and there will be a loss of control of distribution management. Although initiatives must continue to lessen the pipeline through which supplies flow, the stop

point of that distribution must be identified for times of conflict. Additionally, logistics units in support of the forward combat elements must understand procedures will be different on the battlefield.

The RML will happen in response to the design of the *Army After Next* and in peacetime will become the most effective logistics system possible. The initiatives identified in this article will help make this come to fruition and must be aggressively pursued. It will take total understanding of all the issues at hand to ensure this RML does not preclude controlled support on the battlefield.

Notes

1. Distribution Management Center, Tactics, Techniques and Procedures, September 1998.
2. *Ibid.*
3. *Ibid.*
4. *Ibid.*
5. *Ibid.*
6. Combined Logistics Officer Advance Course, Sub-course on Distribution Management, 1997.
7. Velocity Management Training Support Plan, CASCOM, January 1996.
8. *Ibid.*
9. Velocity Management Concept Briefing Fact Sheet, CASCOM 1995.
10. *Ibid.*
11. *Army Logistician*, PB700-98-6, Volume 30, Issue 6, September-October 1998.
12. *Army Logistician*, PB700-99-1, Volume 31, Issue 1, January-February 1999.
13. *Ibid.*
14. *Ibid.*
15. *Ibid.*
16. *Ibid.*
17. *Ibid.*
18. *Ibid.*, 63-64.
19. *Ibid.*
20. *Ibid.*, 33.
21. *Ibid.*, 34.

22. *Ibid.*, 35.
23. *Ibid.*
24. Joint Pub 3-0, II-8.

Major Davidson is an Army transportation officer assigned to USTRANSCOM J3/4. At the time of writing, she was a student at the Air Command and Staff College.

(Just the FAQs—Smart Cards continued from page 21)

URLs for smart cards

- www.scia.org**—The Smart Card Industry Association web site.
- www.plyler.net/SmartCard/**—Connection to the Navy Smart Card Program Office. The Navy is the DoD lead for smart cards.
- www.smartcard.co.uk/tech1.html**—This site gives you a good feel for the whole smart card process, how they're made, and so forth.
- www.ioc.ee/atsc/faq.html**—Contains the current FAQ file for the Usenet newsgroup alt.technology.smartcards. It also has many links to other smart card sites.
- futurefile.com/money.htm**—The future of smart cards, money, finance, and other things, as these people see it.
- www.mastercard.com/smartcard**—At this web site you will find (somewhat *hokey*) demonstrations of what smart cards can do for finance.
- www.visa.com**—Information on the EMV (Europay, MasterCard, and Visa) smart card.
- www.eff.org**—Web site of the Electronic Frontier Foundation. Do a keyword search on *smart card* to find the latest thinking about privacy and security issues for smart cards.
- www.iso.ch**—This is where international standards are born.

Books

- These books are currently available. There are a number of others that are out of print, even though fairly recent.
- Catherine A. Allen (editor), William J. Barr (contributor), Ron Schultz (editor), *Smart Cards : Seizing Strategic Business Opportunities : The Smart Card Forum*, Irwin Professional Publications, November 1996
- Scott Guthery, Timothy M. Jurgensen, Tim Jurgensen, *Smart Card Developer's Kit*, Macmillan Technical Publishing, 1997
- Mike Hendry, *Smart Card Security and Applications*, Artech House Telecommunications Library, September 1997
- J. Thomas Monk (contributor), Henry N. Dreifus, *Smart Cards: A Guide to Building and Managing Smart Card Applications*, December 1997
- Jose Luis Zoreda, Jose M. Oton (contributor), *Smart Cards*, Artech House, December 1994

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(AFI 63-124 Performance-Based Service Contracts continued from page 26)

work in terms of *what* is the required service rather than *how* to perform the work. They will also include measurable performance objectives and financial (or other) incentives to encourage contractors to develop innovative and cost-effective methods of performing the work.

A Performance-Based Approach. The AFI requires a shift from process-oriented requirements to outcome-based performance standards. In the past, most service contracts described the processes a contractor must use to obtain the desired outputs rather than focusing on the end results. Complying with process-oriented requirements limited contractors' flexibility, often preventing them from implementing innovative, cost-savings approaches

Quality Assurance. AFI 63-124 also shifts inspection from oversight to *insight* because of the new focus on performance-based objectives. The instruction advocates more reliance on the contractor's quality control systems than inspection during performance. The government's quality assurance focuses on final outcomes rather than processes, which significantly reduces quality assurance manning. Wing commanders are encouraged to establish centralized performance management offices, and centralized organizations for quality assurance and customer support. It also allows for the conversion of quality assurance evaluators to quality

assurance specialists (QAS, GS-1910 series). This conversion and centralization provides stability and a quality systems-approach, leading to insight versus oversight.

Emphasis in Using Metrics. Process-oriented requirements require manpower-intensive oversight to survey the entire process, not just the end results. Oversight entails a high number of inspections for each process, and a high number of inspections demands a high number of inspectors (approximately 5,000 across the Air Force). AFI 63-124 now emphasizes using contractor's generated metrics to determine compliance with performance standards. This removes QAEs from actually performing the contractors' quality control program and focuses inspections on validating the contractor's metrics.

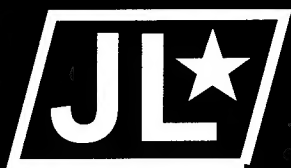
AFI 63-124 improves service contract processes and products, builds functional partnerships, and saves resources. Its philosophy is to provide flexibility, promote acquisition reform principles, emphasize performance-based contracting, and empower the use of the best commercial practices.

Major Bellacicco is a contracting officer currently assigned to the SAF Operational Contracting Division.



The first prerequisite for any regular logistic system is, of course, an exact definition of requirements.

—Martin van Crevald



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